CFTRI-MYSORE
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Solubilities of

# SOLUBILITIES

OF

# ORGANIC COMPOUNDS

*A COMPILATION OF QUANTITATIVE SOLUBILITY DATA FROM THE PERIODICAL LITERATURE*

BY

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# PREFACE

In the preface to the preceding volume of this compilation it was mentioned that the plan of arrangement was being changed from alphabetical in accordance with the English names of the compounds, to alphabetical in accordance with the symbols of the elements. The chemical composition was thus made the basis of the arrangement instead of the names by which the compounds are known.

In this second volume a purely chemical classification has likewise been adopted. It consists in arranging the compounds in accordance with their increasing content of carbon, hydrogen and oxygen. In this way the position of each one is exactly fixed by its empirical formula and the uncertainty is avoided of choosing the best classifying name from the several by which many organic compounds can be correctly designated. The disadvantage of this plan is that empirical formulae are difficult to remember and hence are not easy to use for identifying compounds of carbon. To compensate for this deficiency and provide an additional means of locating desired results, a cross reference name index has been placed at the end of the volume.

In spite of the considerable progress which has been made in recent years in perfecting the rules for naming and representing the structural formulae of organic compounds, an entirely satisfactory system of their classification has still not been perfected. One of the best of those based upon nomenclature is that used by Dr. Austin M. Patterson in his table of Physical Constants of Organic Compounds, published on pages 484-747 of the 20th Edition of the Handbook of Chemistry and Physics, 1935, (Chemical Rubber Publishing Co., Cleveland, Ohio.) It is a pleasure to acknowledge the aid this table has been as a guide in selecting the preferred names and formulae of the compounds included in the present compilation. It has also been especially helpful in tracing the identity of compounds which have been referred to only by name in many of the original papers in which solubility results are given.

Although in most cases the name may be a sufficient identification, language differences and nomenclature revisions often add greatly to the difficulty of tracing the formula corresponding to a given name. The failure to record the structural formula as well as to specify the exact terms in which the results are expressed, may render the most careful work of little value.

Furthermore, results are often reported only in terms selected to demonstrate some theoretical relationship and insufficient details are given to permit their recalculation to the original basis upon which

they were determined. This limits the use which might be made of them in the solution of other problems. It would indeed be a great advantage if the structural formula was given at least one time in every paper and the original numerical values in which the determinations were made, recorded in every case.

As in all previous editions of this compilation the question of where to draw the line in regard to results which are of sufficient interest to be included has been a difficult problem. The published results vary from the most accurate quantitative studies to simple observations of approximate solubilities under loosely controlled conditions. These latter are usually given in connection with descriptions of the preparation and properties of organic compounds and are thus very widely scattered in the literature. They have for the most part been incorporated in the descriptions of organic compounds given in Beilstein and other compendia. To have included them in this volume would have amounted to republication of information usually sought and easily found elsewhere. In general, therefore, it may be said that the present compilation is confined to results taken from original papers and having an interest from the quantitative solubility standpoint.

Solutions are in all cases mixtures from which the constituents cannot be separated mechanically. Solubilities express the amounts beyond which a given compound will not mix with one or more other compounds under fixed conditions. Due to the several states in which matter exists, solubilities may be of quite varied character. In general, however, the ordinary conception of solubility is limited to only a few of the numerous variations which are possible. It will probably be a surprise to some that so much space has been given in the present volume to freezing-points. They are, however, one of the most universal examples of quantitative solubility data. They differ from what is usually looked upon as solubility, in that the end point is reached in a different manner. Thus a mixture of two compounds rendered liquid by elevation of temperature, on gradually being cooled will reach a point, called the freezing-point, at which one or the other of the constituents will separate as a solid. This point represents the solubility of one compound in the other. The method involved differs principally from that ordinarily employed for solubility determinations in that the composition of the mixture remains constant while the saturation temperature is being approached, instead of the reverse procedure.

A very large number of solubility determinations made by the freezing point method are available, but for the most part they are not of as general interest as the results of the determinations made by the more familiar methods. Therefore, references only to such data are given. Since in all cases each of the two or more compounds involved in a

freezing-point may be the solute, references to each constituent are needed. In previous editions each system was recorded only under the name of that constituent the initial of which came first in the alphabet, and the name of the other constituent was given in the index. In the present volume an attempt has been made to record every system under the name of each of the constituents of which it is composed. Thus, in the case of all but a few of the more complex ones, there are assembled under every compound for which data are available, the names of all other compounds with which its freezing-point has been determined.

As in the case of the preceding volume the text of the present one has been prepared for planographic reproduction by combining the new data, typewritten on a "Varityper" and photographically reduced, with those tables of the previous editions which have not been superseded by more accurate determinations. The result leaves much to be desired from the point of view of typography, but, as in the case of the previous volume, this method was the only one of which the cost was not prohibitive. The main purpose has been to secure clearness, even at the expense of monotonous repetitions and uniformity of appearance. In view of the large numbers of results which have been collected and systematically arranged it can hardly be expected that complete freedom from typographical and other errors has been attained. The best that can be hoped is that very few of the errors which will inevitably be found will be of a misleading character.

A.S.

Washington, D. C., September 1, 1941.

# ABBREVIATIONS

Most of the following abbreviations will be found written both with capitals and without.

$[\alpha]_D$. — Specific Rotation.
abs. — Absolute.
abs. coef. — Absorption Coefficient.
alcohol. — Ethyl Alcohol.
amt(s). — Amount(s).
anhy. — Anhydrous.
aq. — Aqueous.
atm(s). — Atmosphere(s).
at. wt. — Atomic Weight.
b.-pt. — Boiling-point.
C. — Centigrade.
calc. — Calculate(ed).
cc. — Cubic Centimeter(s).
cm. — Centimeter(s).
coef. — Coefficient.
com. — Commercial.
compd. — Compound.
conc. — Concentration, Concentrated.
cond. — Conductivity.
const. — Constant.
cor. — Corrected.
crit. — Critical.
cryo. — Cryohydric.
cryst. — Crystalline.
*d.* — Dextro (in connection with the name of an optically active compound).
*d.* — Density ($d_{18}$ — Specific Gravity at 18°, referred to water at 4°; $d_{\frac{20}{20}}$ at 20° referred to water at 20°).
decomp. — Decomposition.
dif. — Different.
dil. — Dilute.
dist. coef. — Distribution Coefficient.
ed. — Edition.
elec. — Electric(al).
equil. — Equilibrium.
equiv. — Equivalent(s).
eutec. — Eutectic.
F. — Fahrenheit.
f.-pt. — Freezing-point.
g., gm., gms. — Gram(s).
gm. mol. — Gram Molecule(s).
G. M. — Gram Molecule(s).
hr(s). — Hour(s).
*i.* — (*d* + *l*) Inactive (in connection with the name of an optically active compound.)
inorg. — Inorganic.
insol. — Insoluble.
*l.* — Lævo (in connection with the name of an optically active compound).
kg. kgm. — Kilogram(s).
l. — Liter(s).
mm. — Millimeter(s)
*m.* — Meta.
max. — Maximum.
mg., mgm. — Milligram(s).
mol(s). — Molecule(s), Molecular.
mol. wt. — Molecular Weight.
millimol. — Milligram Molecule.
m.-pt. — Melting-point.
*n.* — Normal (gm. equiv. per l.).
N. — Normal (used rarely).
*o.* — Ortho.
ord. — Ordinary.
org. — Organic.
p. — Page.
*p.* — Para.
pet. — Petroleum.
ppt. — Precipitate.
pt. — Point.
quad. pt. — Quadruple Point.
qual. — Qualitative.
sapon. — Saponification.
sat. — Saturated.
sol(s). — Solution(s).
sp. gr. — Specific Gravity (Density).
sq. cm. — Square Centimeter.
*s.* — Symmetrical.
sym. — Symmetrical.
t°. — Temperature, Centigrade Scale.
temp(s). — Temperature(s).
tr. pt. — Transition Point.
vol(s). — Volume(s).
undissoc. — Undissociated.
U. S. P. — U. S. Pharmacopœia.
wt. — Weight.
$\infty$ — Infinity.
$.10^{-2}$, $.10^{-5}$, etc., following a result means that the decimal point is to be moved as many places to the left as indicated by the minus exponent.

# CARBON Tetra BROMIDE $CBr_4$.

## Solubility of Carbon Tetrabromide in Water.
(Gross and Saylor, 1931.)

The saturated solution was prepared by shaking in a thermostat and analyzed by means of an interferometer.

100 gms. $H_2O$ dissolve 0.024 gm. $CBr_4$ at 30°.

Results for the fusion and transformation points of mixtures of $CBr_4$ + $CCl_4$ are given in the form of a diagram by Sohier, 1931. The determinations were made by recording with a thermocouple the temperature changes at regular intervals during the cooling and the heating of known mixtures of the two compounds. The curves for both fusion and transformation decend continuously from the fusion and transformation points of $CBr_4$ to those of $CCl_4$. At concentrations of $CBr_4$ greater than 75% decomposition prevented direct determinations of the fusion points.

Results are also given for the distribution of $CCl_4$ between aqueous 70% $CH_3OH$ solution and mixed crystals of $CBr_4$ + $CCl_4$. In connection with these determinations an analytical method for determining the halogens in presence of each other is described.

Later studies of this system directed particularly toward determining the molecular size of the α polymorphic form of these compounds are given by Verstraete, 1934. Results for the distribution between the saturated vapor phase and mixed crystals of $CBr_4$ + $CCl_4$, containing 20% of $CCl_4$ are given.

### Fusion-points of Mixtures of Carbon Tetrabromide and Chloroform.
(Verstraete, 1934.)

| t° | Gms. $CBr_4$ per 100 gms. mixture | t° | Gms. $CBr_4$ per 100 gms. mixture | t° | Gms. $CBr_4$ per 100 gms. mixture |
|---|---|---|---|---|---|
| 92.3 | 100. | 6.7 | 60.73 | -40.55 | 30.05 |
| 39.7 | 85.35 | 0.4 | 57.07 | -49.4 | 25.59 |
| 28.4 | 77.25 | -14.4 | 46.28 | -63.7 (Eutec) | 19.3 |
| 18.0 | 69.50 | -32.0 | 35.03 | -63.3 | 0.0 |

### Fusion-points of Mixtures of Carbon Tetrabromide and Pentachlorethane.
(Verstraete, 1934.)

| t° | Gms. $CBr_4$ per 100 gms. mixture | t° | Gms. $CBr_4$ per 100 gms. mixture | t° | Gms. $CBr_4$ per 100 gms. mixture |
|---|---|---|---|---|---|
| 92.3 | 100 | 13.0 | 57.51 | -36.5 (Eutec) | 25.48 |
| 58.6 | 87.29 | 0.2 | 48.23 | -32.0 | 12.10 |
| 42.9 | 80.77 | -13.6 | 40.55 | -29.5 | 0.0 |
| 26.6 | 69.06 | -23.7 | 34.26 | | |

## CARBON Tetra CHLORIDE $CCl_4$ (See also Vol. I, p. 214 and p. 584)

### Solubility of Carbon Tetrachloride in Water.

(Gross, 1929; Gross and Saylor, 1931.)

| $t^o$ | Gms. $CCl_4$ per 1000 gms. $H_2O$ | Gm. Mol. $CCl_4$ per 1000 gms. $H_2O$ |
|---|---|---|
| 15 | 0.77 | 0.0050 |
| 25 | 0.77 | 0.0050 |
| 30 | 0.81 | 0.0053 |
| 28.5 | 0.13 (Clifford, 1921.) | |

The saturated solution was prepared by shaking in a thermostat and analyzed by means of an interferometer.

### Solubility of Water in Carbon Tetrachloride. (See also Vol. I, p. 584)

(Rosenbaum and Walton, 1930.)

| $t^o$ | Gms. $H_2O$ per 100 gms. $CCl_4$ | $t^o$ | Gms. $H_2O$ per 100 gms. $CCl_4$ |
|---|---|---|---|
| 10 | 0.00711 | 30 | 0.0109 |
| 20 | 0.00844 | 40 | 0.0152 |
| 24 | 0.010 (Clifford, 1921.) | 50 | 0.0237 |

### Solubility of Carbon Tetrachloride in Aqueous Salt Solutions.

(Gross, 1929.)

| Solvent | $t^o$ | Gms. $CCl_4$ per 1000 gms. $H_2O$ |
|---|---|---|
| Aq. 0.5 normal KCl | 25 | 0.65 |
| Aq. 0.5 normal $MgSO_4$ | 25 | 0.48 |

### Reciprocal Solubility of Carbon Tetrachloride, Water and Alkyl Acids at 25°.

(Smith and Berman, 1937.)

The determinations were made by titrating mixtures of two of the components with the third until homogenity resulted or a permanent cloud separated.

Results for mixtures containing:

Formic Acid

| Gm. Mol. Percent | | |
|---|---|---|
| $CCl_4$ | HCOOH | $H_2O$ |
| 0.01 | 0.0 | 99.9 |
| 0.15 | 40.0 | 60.0 |
| 0.30 | 49.0 | 51.0 |
| 0.40 | 55.0 | 44.0 |
| 0.60 | 63.0 | 36.0 |
| 0.90 | 74.0 | 24.0 |
| 2.2 | 94.0 | 3.9 |
| 2.7 | 97.3 | 0.0 |
| 91.2 | 8.8 | 0.0 |
| 99.9 | 0.0 | 0.1 |

Acetic Acid

| Gm. Mol. Percent | | |
|---|---|---|
| $CCl_4$ | $CH_3COOH$ | $H_2O$ |
| 0.01 | 0 | 99.9 |
| 0.3 | 5.2 | 94.5 |
| 0.3 | 9.5 | 90 |
| 0.4 | 14.4 | 85 |
| 0.4 | 20.0 | 79 |
| 0.5 | 28.0 | 72 |
| 2.4 | 46.0 | 52 |
| 5.2 | 54.0 | 41 |
| 9.2 | 58.0 | 33 |

| Gm. Mol. Percent | | |
|---|---|---|
| $CCl_4$ | $CH_3COOH$ | $H_2O$ |
| 11.4 | 58 | 33 |
| 15.0 | 58 | 27 |
| 23 | 57 | 20 |
| 27 | 55 | 18. |
| 32 | 53 | 15 |
| 48 | 44 | 8.0 |
| 55 | 39 | 6.2 |
| 61 | 34 | 4.4 |
| 69 | 29 | 1.9 |
| 99.9 | 0 | 0.1 |

CARBON Tetra CHLORIDE

## Reciprocal Solubility of Carbon Tetrachloride, Water and Alkyl Acids at 25°. (Con.)

Results for Mixtures containing:

### Propionic Acid

| Gm. Mol. Percent | | |
|---|---|---|
| $CCl_4$ | $C_2H_5COOH$ | $H_2O$ |
| 0.01 | 0.0 | 99.0 |
| 0.2 | 5.7 | 94 |
| 0.5 | 19 | 80 |
| 1.5 | 26 | 72 |
| 5.0 | 33 | 62 |
| 13 | 40 | 47 |
| 17 | 44 | 39 |
| 31 | 47 | 22 |
| 42 | 46 | 12 |
| 49 | 43 | 8.3 |
| 55 | 40 | 5.5 |
| 63 | 35 | 2.4 |
| 75 | 25 | 0.1 |
| 99.9 | 0 | 0.1 |

### n Butyric Acid

| Gm. Mol. Percent | | |
|---|---|---|
| $CCl_4$ | $C_3H_7COOH$ | $H_2O$ |
| 0.01 | 0. | 99.9 |
| 0.1 | 4.7 | 95 |
| 1.4 | 22 | 76 |
| 4.8 | 35 | 60 |
| 7.7 | 40 | 52 |
| 15 | 50 | 35 |
| 28 | 51 | 21 |
| 45 | 47 | 7.7 |
| 56 | 39 | 5.0 |
| 59 | 37 | 4.1 |
| 64 | 33 | 3.0 |
| 68 | 30 | 2.1 |
| 79 | 21 | 0.3 |
| 99.9 | 0 | 0.1 |

### n Valeric Acid

| Gm. Mol. Percent | | |
|---|---|---|
| $CCl_4$ | $C_4H_9COOH$ | $H_2O$ |
| 0.01 | 0. | 99.9 |
| 0. | 0.695 | 99.3 |
| 0. | 50.5 | 49.5 |
| 7.1 | 58 | 35 |
| 17 | 62 | 21 |
| 24 | 61 | 15 |
| 40 | 57 | 3.1 |
| 73 | 26 | 0.6 |
| 99.9 | 0 | 0.1 |

### n Caproic Acid

| Gm. Mol. Percent | | |
|---|---|---|
| $CCl_4$ | $C_5H_{11}COOH$ | $H_2O$ |
| 0.01 | 0. | 99.9 |
| 0. | 0.16 | 99.84 |
| 0. | 69.5 | 30.5 |
| 5.7 | 73. | 21 |
| 14. | 72. | 14 |
| 22. | 68. | 9.5 |
| 44 | 53 | 2.6 |
| 72 | 28 | 0.4 |
| 99.9 | 0 | 0.1 |

### n Heptylic (Enanthic) Acid

| Gm. Mol. Percent | | |
|---|---|---|
| $CCl_4$ | $C_6H_{13}COOH$ | $H_2O$ |
| 0.01 | 0. | 99.99 |
| 0. | 0.053 | 99.95 |
| 0. | 78.3 | 21.7 |
| 5.9 | 80 | 14.0 |
| 11. | 78 | 11. |
| 22. | 73 | 5.2 |
| 29 | 67 | 4.2 |
| 38 | 60 | 2.1 |
| 69 | 31 | 0.3 |
| 99.9 | 0 | 0.1 |

## Reciprocal Solubility of Carbon Tetrachloride, Water and Methyl Alcohol.

(Sata and Niwase, 1937.)

The temperatures were determined at which known mixtures of the three components were homogenous, opalescent and cloudy.

| Percentage composition of Mixture | | | $t^0$ of: | | |
|---|---|---|---|---|---|
| $CCl_4$ | $CH_3OH$ | $H_2O$ | Homogeneity | Opalence | Cloudiness |
| 65.2 | 32.7 | 2.1 | 28.0 | 27.5 - 22.5 | 20.5 |
| 65.1 | 32.7 | 2.2 | 28.0 | 27.5 - 20.5 | 18.5 |
| 65.0 | 32.6 | 2.4 | 34.0 | 33.0 - 31.0 | 28.0 |
| 64.9 | 32.6 | 2.5 | — | — | 30.0 |
| 82.78 | 16.56 | 0.66 | — | — | 30.0 |
| 47.6 | 47.7 | 4.7 | — | — | 30.0 |
| 30.5 | 61.1 | 8.4 | — | — | 30.0 |
| 13.6 | 68.6 | 17.8 | — | — | 30.0 |
| 0.99 | 49.51 | 49.5 | — | — | 30.0 |
| 0.66 | 33.14 | 66.86 | — | — | 30.0 |

The authors also give results showing the volumes of the layers formed when increasing amounts of methyl alcohol are added to known mixtures of carbon tetrachloride and water.

# CARBON TetraCHLORIDE

## Miscibility of Carbon Tetrachloride, Water and Ethyl Alcohol at 0°.
(Bonner, 1910.)

Note.—The determinations were made by gradually adding ethyl alcohol to mixtures of the given amounts of water and the other constituent until a homogeneous solution was obtained. The results give the binodal curve for the system. The author also determined "tie lines" showing the compositions of various pairs of liquids which may exist in equilibrium. As the two layers approach each other in composition, the tie line is gradually shortened and finally reduced to a point, designated as the "plait point" of the binodal curve. This point is indicated by a * in the tables. The mixtures above and below the * correspond, according to their Sp. Gr., to the upper and lower layers of the system.

| Composition of Homogeneous Mixtures | | | | Composition of Homogeneous Mixtures | | | |
|---|---|---|---|---|---|---|---|
| Gms. $CCl_4$ | Gms. $H_2O$ | Gms. $C_2H_5OH$ | Sp. Gr. sat. sol. | Gms. $CCl_4$ | Gms. $H_2O$ | Gms. $C_2H_5OH$ | Sp. Gr. sat. sol. |
| 0.961 | 0.039 | 0.224 | 1.36 | 0.60 | 0.40 | 0.94 | 1.03 |
| 0.928 | 0.072 | 0.347 | 1.23 | 0.499 | 0.501 | 1.04 | 1.0 |
| *0.92 | 0.08 | 0.39 | — | 0.40 | 0.60 | 1.0 | 0.97 |
| 0.90 | 0.10 | 0.45 | 1.20 | 0.25 | 0.75 | 1.105 | 0.95 |
| 0.80 | 0.20 | 0.64 | 1.15 | 0.10 | 0.90 | 1.0 | 0.92 |
| 0.70 | 0.30 | 0.82 | 1.07 | 0.032 | 0.968 | 0.745 | 0.93 |

100 gms. Aq. 0.4 normal Sodium Oleate Solution (= 10.8 gm. Na Oleate per 100 gms. solution) dissolve 6.65 gms. $CCl_4$ at 20°. (Smith, 1932.)

## Reciprocal Solubility of Carbon Tetrachloride and Sulfur Dioxide.
(Bond and Beach, 1926.)

| t° of complete miscibility | Gms. $CCl_4$ per 100 gms. sat. sol. | t° of complete miscibility | Gms. $CCl_4$ per 100 gms. sat. sol. |
|---|---|---|---|
| -37.2 | 28.36 | -29.8 | 66.26 |
| -35.2 | 31.66 | -33.57 | 80.83 |
| -29.68 | 49.93 | -34.9 | 82.56 |
| -29.27 | 58.19 | -39.8 | 88.44 |
| -29.37 | 58.98 | | |

## Fusion-points of Mixtures of Carbon Tetrachloride and Chloroform.
(Verstraete, 1934.)

| t° | Gms. $CCl_4$ per 100 gms. mixture | t° | Gms. $CCl_4$ per 100 gms. mixture | t° | Gms. $CCl_4$ per 100 gms. mixture |
|---|---|---|---|---|---|
| -68.0 | 20.00 | -73.1 | 56.40 | -54.6 | 82.76 |
| -69.0 | 24.94 | -67.8 | 68.58 | -49.65 | 87.59 |
| -73.4 | 37.96 | -63.05 | 73.85 | -36.35 | 94.38 |
| -77.7 (Eutec.) | 46.52 | -58.3 | 79.18 | -22.9 | 100.00 |

## Fusion-points of Mixtures of Carbon Tetrachloride and Pentachlor Ethane.
(Verstraete, 1934.)

| t° | Gms. $CCl_4$ per 100 gms. mixture | t° | Gms. $CCl_4$ per 100 gms. mixture | t° | Gms. $CCl_4$ per 100 gms. mixture |
|---|---|---|---|---|---|
| -37.2 | 10.66 | -62.8 | 46.75 | -53.6 | 75.67 |
| -43.4 | 17.48 | -66.5 | 55.02 | -45.4 | 84.32 |
| -49.8 | 27.82 | -68.4 (Eutec.) | 58.33 | -36.4 | 90.09 |
| -55.4 | 39.41 | -63.75 | 63.21 | -22.9 | 100.00 |

## Distribution of Carbon Tetrachloride Between Methyl Alcohol and Oil of Vaseline at 25°.

(Kozakewitch, 1936.)

| Gm. Mol. $CCl_4$ per 1000 gms: $CH_3OH$(s) | Vaseline(v) | $\frac{s}{v}$ | Gm. Mol. $CCl_4$ per 1000 gms.: $CH_3OH$(s) | Vaseline(v) | $\frac{s}{v}$ |
|---|---|---|---|---|---|
| 0.189 | 0.180 | 1.05 | 0.352 | 0.340 | 1.04 |
| 0.324 | 0.303 | 1.07 | 0.453 | 0.440 | 1.02 |

The author also gives results showing the effect of various salts upon the above distribution.

## Freezing-points of Mixtures of Carbon Tetrachloride and Ethyl Alcohol.

(Wyatt, 1928.)

| t° | Gm. Mol. Percent of $CCl_4$ in mixture | Solid Phase |
|---|---|---|
| -117.3 | 0.0 | $C_2H_5OH$ |
| -118. (Eutec.) | 11.0 | " + $CCl_4$ |
| -47.6(tr.pt.) | 44.6 | $CCl_4.(?)C_2H_5OH$ + $CCl_4$ |
| -22.8 | 100.0 | $CCl_4$ |

Other determinations are given only as points on the diagram. The author also gives the internal molal latent heat curve of the system.

## Freezing-points of Mixtures of Carbon Tetra chloride and Ethyl Ether.

(Wyatt, 1929.)

| t° | Gm. Mol. Percent of $CCl_4$ in Mixture | Solid Phase |
|---|---|---|
| -116.2 | 0.0 | $(C_2H_5)_2O$ |
| -118.5 (Eutec.) | 5.4 | " + $2(C_2H_5)_2O.CCl_4$ |
| -122.5 (Eutec.*) | 12.5 | $(C_2H_5)_2O$ + $(C_2H_5)_2O.CCl_4$ |
| -107. (tr. pt.) | 18.0 | $2(C_2H_5)_2O.CCl_4 \rightarrow (C_2H_5)_2O.CCl_4$ |
| - 86.5 (m. pt.) | — | $(C_2H_5)_2O.CCl_4$ " $\rightarrow CCl_4$ |
| - 48.2 (tr. pt.) | 89.0 | |
| - 22.8 | 100.0 | $CCl_4$ |

* = Metastable Eutec.

Other determinations are given only as points on the diagram. Results for the internal molal latent heats of evaporation are also given.

## Freezing-points of Mixtures of Carbon Tetrachloride and Ethyl Acetate.

(Wyatt, 1929.)

| t° | Gm. Mol. Percent of $CCl_4$ in Mixture | Solid Phase |
|---|---|---|
| -83.6 | 0.0 | $CH_3COOC_2H_5$ |
| -90 (Eutec. tr.) | 16.5 | " + $2(CH_3COOC_2H_5).CCl_4(?)$ |
| -86(?)(m. pt.(?)) | 33.3 | $2(CH_3COOC_2H_5).CCl_4$ |
| -87 (Eutec. tr.?) | 42.0 | $CH_3COOC_2H_5.CCl_4$ or $2(CH_3COOC_2H_5)CCl_4$ |
| -47.8 (tr. pt.) | 86.1 | " + $CCl_4$ |

Other determinations are given only as points on the diagram. Results for the latent heat curve fall close to a straight line.

MUTUAL SOLUBILITY OF BENZENE AND CARBON TETRACHLORIDE.
(Determined by the synthetic method.)
(Baud, 1913.)

| t°. | Gms. $C_6H_6$ per 100 Gms. Mixture. | t°. | Gms. $C_6H_6$ per 100 Gms. Mixture. | t°. | Gms. $C_6H_6$ per 100 Gms. Mixture. |
|---|---|---|---|---|---|
| −24.2 | 0 | −40 | 19.3 | −20 | 48 |
| −30 | 2.8 | −34 | 24.2 | −10 | 64.1 |
| −40 | 8.5 | −35 tr. pt. | 31 | 0 | 85.3 |
| −46.3 Eutec. | 12.9 | −30 | 36 | + 5.5 | 100 |

Freezing-point data are given for the following systems:

$CCl_4$ + $CHCl_3$ (Timmermans, 1928; Sameshima and Hiramatsu, 1934.)
+ $CH_2:CHBr$ (Ethylene bromide) (Linhard, 1925.)
+ 1.2, $C_2H_4Br_2$ (Di brom Ethane) (Timmermans, 1928.)
+ $(CH_3)_2CO$ (Acetone) (Timmermans, 1928; Wyatt, 1929.)
+ $CS_2$ (Timmermans, 1928.)
+ $C_6H_6$ (Linard, 1925; Lauer and Stodola, 1934.)
+ $C_6H_6NH_2$ (Timmermans, 1930.)
+ $C_6H_5NO_2$ (Linard, 1925; Hrynakowski and Szmyt, 1928.)
+ $C_6H_{12}$ (Cyclohexane) (Timmermans, 1928.)

## TRI CHLORO MONO FLURO METHANE $CCl_3F$.

SOLUBILITY OF TRICHLORO MONOFLUORO METHANE IN ORGANIC SOLVENTS AT 32°.
(Zellhoeffer, 1937; Zellhoeffer, Copley and Marvel, 1938)1)

| Solvent | Formula | Gms. $CCl_3F$ per 100 cc solvent at 364 mm. pressure(1) |
|---|---|---|
| Carbitol Acetate | $C_2H_5O(CH_2CH_2O)_2COCH_3$ | 28.6 |
| Di ethyl ether of tetra ethylene glycol | $C_2H_5O(CH_2CH_2O)_4C_2H_5$ | 21.6 |
| Ethyl ether of diethylene glycol acetate | $C_2H_5O(CH_2CH_2O)_2COCH_3$ | 33.8(2) |
| Di methyl ether of tetra ethylene glycol | $CH_3O(CH_2CH_2O)_4CH_3$ | 30.2(2) |
| Di ethyl ether of di ethylene glycol | $C_2H_5O(CH_2CH_2O)_2C_2H_5$ | 49.5(2) |

(1) Vapor pressure of $CCl_3F$ at 4.5°; (2) Gms. per 100 gms. solvent at 364 mm pressure and 32.2°.

## DI CHLORO DI FLUORO METHANE $CCl_2F_2$.

SOLUBILITY OF DICHLORO DIFLUORO METHANE IN ORGANIC SOLVENTS AT 32°.
(Zellhoeffer, 1937; Zellhoeffer, Copley and Marvel, 1938.)

| Solvent | Formula | Gms. $CCl_2F_2$ per 100 cc solvent at 2693 mm pressure(1) |
|---|---|---|
| Carbitol Acetate | $C_2H_5O(CH_2CH_2O)_2COCH_3$ | 25.8 |
| Carbitol ethyl ether | $C_2H_5O(CH_2CH_2O)_2C_2H_5$ | 38.0 |
| Di ethyl ether of tetra ethylene glycol | $C_2H_5O(CH_2CH_2O)_4C_2H_5$ | 25.8 |
| Carbitol methoxy acetate | $C_2H_5O(CH_2CH_2O)_2COCH_2OCH_3$ | 16.2 |
| 4-Methyl -2 pentanol acetate | $(CH_3)_2CHCH_2CH(OCOCH_3)CH_3$ | 52.0 |
| 2,3 Di β' ethoxy-β-ethoxy dioxane | $C_{12}H_{24}O_6$ | 19.6 |
| y,y' Di chloro-n - propyl ether | $(ClCH_2CH_2CH_2)_2O$ | 22.0 |
| Di chloro iso propyl ether | $(C_3H_6Cl)_2O$ | 25.8 |
| ∝ Fluoro naphthalene | $C_{10}H_7F$ | 23.6 |
| Tri chloro benzene | $C_6H_3Cl_3$ | 20.4 |
| Ethyl ether or di ethylene glycolacetate | $C_2H_5O(CH_2CH_2O)_2COCH_3$ | 26.7(2) |
| Di methyl ether or tetra ethylene glycol | $CH_3O(CH_2CH_2O)_4CH_3$ | 21.5(2) |
| Di ethyl ether or di ethylene glycol | $C_2H_5O(CH_2CH_2O)_2C_2H_5$ | 45.8(2) |

(1) Vapor pressure of $CCl_2F_2$ at 4.5°; (2) Gms. per 100 gms. solvent at 2693 mm. pressure and 32.2°.

## TETRACHLORO ETHYLENE $CCl_2:CCl_2$.

Freezing-point data for mixtures of tetrachloro ethylene and tetra chloro ethane ($C_2H_2Cl_4$) are given by Timmermans and Mme. Vesselovsky, 1931.

## DICHLORO TETRAFLUORO ETHANE $C_2Cl_2F_4$.

SOLUBILITY OF DICHLORO TETRAFLUORO ETHANE IN ORGANIC SOLVENTS AT 32°.
(Zellhoeffer, 1937; Zellhoeffer, Copley and Marvel, 1938.)

| Solvent | Formula | Gms. $C_2Cl_2F_4$ per 100 cc solvent at 786 mm pressure (1) |
|---|---|---|
| Carbitol acetate | $C_2H_5O(CH_2CH_2O)_2COCH_3$ | 16.2 |
| Di methyl ether of tetraethylene glycol | $CH_3O(CH_2CH_2O)_4CH_3$ | 13.8 |
| Ethyl ether of di ethylene glycol acetate | $C_2H_5O(CH_2CH_2O)_2COCH_3$ | 15.5(2) |
| Dimethyl ether of tetra ethylene glycol | $CH_3O(CH_2CH_2O)_4CH_3$ | 12.0(2) |
| Diethyl ether of di ethylene glycol | $C_2H_5O(CH_2CH_2O)_2C_2H_5$ | 30.0(2) |

(1) Vapor pressure of $C_2Cl_4F_4$ at 4.5°.
(2) Gms. per 100 gms. solvent at 786 mm pressure and 32.2°.

## TRICHLORO TRIFLUORO ETHANE $C_2Cl_3F_3$.

### Solubility of Trichloro Trifluoro Ethane in Organic Solvents at 32.2°.

(Zellhoeffer, Copley and Marvel, 1938.)

| Solvent | Formula | Gms. $C_2Cl_3F_3$ per 100 gms. solvent(1) |
|---|---|---|
| Ethyl ether of di ethylene glycol acetate | $C_2H_5O(CH_2CH_2O)_2COCH_3$ | 33.0 |
| Di methyl ether of tetra ethylene glycol | $CH_3O(CH_2CH_2O)_4CH_3$ | 27.5 |
| Di ethyl ether of di ethylene glycol | $C_2H_5O(CH_2CH_2O)_2C_2H_5$ | 46.5 |

(1) At a pressure of $C_2Cl_3F_3$ corresponding to its vapor pressure at 4.5°.

## CHLOROPICRIN (Trichloronitromethane) $CCl_3NO_2$.

### Reciprocal Solubility of Chloropicrin and Water. (Thompson and Black, 1920.)

Chloropicrin was shaken with a large amount of water to form an emulsion. The mixture was allowed to stand 3 days at room temperature and then maintained at 25° for 6 hours. The chlorine in 100 cc. of the solution was determined. A similar experiment was made at 0°. For the 75° result the solution sat. at 0° waw kept 2 days in a thermostat at 75°.

| t° | 0°. | 25°. | 75°. |
|---|---|---|---|
| Gms. $CCl_3NO_2$ per 100 cc. $H_2O$ | 0.2272 | 0.1621 | 0.1141 |

For the determination of the solubility of water in chloropicrin, a small amount of water was dissolved in a large amount of chloropicrin and the mixture slowly cooled untill a white cloud appeared. The temperature was then slowly raised untill clearing occurred. The average of the temperature of clouding and of clearing was taken as the temperature of solubility.

| t° | 32°. | 36°. | 41°. | 48°. | 50°.8. | 55°. |
|---|---|---|---|---|---|---|
| Gms. $H_2O$ per 100 gms. $CCl_3NO_2$. | 0.1003 | 0.1185 | 0.1243 | 0.1647 | 0.1853 | 0.2265 |

Freezing-point data for mixtures of chloropicrin and nitrogen peroxide are given by Pascal, 1923.

Results for mixtures of chloropicrin and tetra nitro methyl aniline are given by Jefremow and Tichomirowa, 1928.

## PHOSGENE (Carbonyl Chloride) $COCl_2$. (See also Vol. I, p. 237.)

### Vapor Pressures of Mixtures of Phosgene and Various Solvents.

(Kirelew, Kaplan and Wasnewa, 1936.)

Instead of the direct method used by Atkinson, Heycock and Pope, 1920 and Baskerville and Cohen, 1921, for the solubility of Phosgene in various solvents (See Volume I, p. 237.) the authors made determinations of the differences in pressure of mixtures of phosgene and various solvents at several temperatures.

Results at −15° for mixtures of Phosgene and:

| DiChloro Ethane, $C_2H_4Cl_2$ | | | | Xylol, $C_6H_4(CH_3)_2$ | | | |
|---|---|---|---|---|---|---|---|
| Wt. % $COCl_2$ in solution | Total Vapor Pressure mm. | Wt. % $COCl_2$ in Solution | Total Vapor Pressure mm. | Wt. % $COCl_2$ in Solution | Total Vapor Pressure mm. | Wt. % $COCl_2$ in Solution | Total Vapor Pressure mm. |
| 0.0 | 8. | 18.02 | 90.4 | 0.0 | 0.0 | 33.32 | 124. |
| 1.13 | 25.4 | 23.0 | 102.4 | 3.36 | 31 | 42.0 | 145 |
| 3.45 | 37.4 | 28.8 | 121.4 | 6.21 | 48 | 48.8 | 162 |
| 5.75 | 45.4 | 36.02 | 143.3 | 13.1 | 67 | 54.1 | 176. |
| 8.02 | 56.4 | 42.1 | 162 | 21.83 | 92 | 100.0 | 282.5 |
| 12.24 | 70.4 | 46.9 | 179.4 | 27.55 | 108 | | |

VAPOR PRESSURES OF MIXTURES OF PHOSGENE AND VARIOUS SOLVENTS. (Con.)

Results at 0° for mixtures of Phosgene and:

| Dichlor Ethane, $C_2H_4Cl_2$ | | Xylene, $C_6H_4(CH_3)_2$ | | Chloro Benzene, $C_6H_5Cl$ | |
|---|---|---|---|---|---|
| Wt. % $COCl_2$ in Solution | Total Vapor Pressure, mm. | Wt. % $COCl_2$ in Solution | Total Vapor Pressure, mm. | Wt. % $COCl_2$ in Solution | Total Vapor Preasure, mm. |
| 0. | 20.6 | 0.0 | 6. | 0.0 | 2.56 |
| 2.32 | 74 | 3.57 | 38.6 | 2.8 | 35.0 |
| 4.71 | 98 | 6.81 | 65.6 | 5.5 | 60.0 |
| 7.0 | 119 | 15.57 | 134.6 | 12.8 | 121. |
| 11.26 | 154 | 22.93 | 180.6 | 19.0 | 168. |
| 16.98 | 209 | 29.11 | 242.6 | 24.5 | 206. |
| 22.06 | 238 | 38.11 | 280.6 | 33.5 | 262. |
| 30.48 | 292 | 46.72 | 324.6 | 40.6 | 301. |
| 37.36 | 335 | 52.48 | 355.6 | 46.4 | 338. |
| 42.97 | 367 | 57.22 | 380.6 | 51.1 | 360. |
| 48.36 | 390 | 61.1 | 395.6 | 55.1 | 381. |
| 51.78 | 405 | 100.0 | 556.5 | 100. | 556.5 |
| 54.56 | 423 | | | | |

Results at 20° for mixtures of Phosgene and:

| Benzene $C_6H_6$ | | Xylene $C_6H_4(CH_3)_2$ | | Toluene $C_6H_5CH_3$ | | Dichloro Ethane $C_2H_4Cl_2$ | |
|---|---|---|---|---|---|---|---|
| Wt. % $COCl_2$ in Solution | Total Vapor Pressure | Wt. % $COCl_2$ in Solution | Total Vapor Pressure | Wt. % $COCl_2$ in Solution | Total Vapor Pressure | Wt. % $COCl_2$ in Solution | Total Vapor Pressure |
| 0. | 74.6 | 0.0 | 10 | 0.0 | 21 | 0.0 | 60.5 |
| 2.30 | 136.6 | 9.0 | 212.5 | 9.5 | 184.8 | 6.8 | 187.3 |
| 8.97 | 234.6 | 16.8 | 342. | 24.3 | 421 | 12.9 | 284.3 |
| 16.83 | 336.6 | 23.2 | 441. | 36.94 | 567 | 18.7 | 364.3 |
| 23.83 | 422.5 | 29.4 | 521.5 | 43.62 | 651 | 23.17 | 432.3 |
| 29.43 | 488.6 | 34.5 | 582.5 | 47.07 | 702 | 28.75 | 504.3 |
| 34. | 541.1 | 38.9 | 633.7 | 50.1 | 747 | 34.71 | 582.3 |
| 38.75 | 603.9 | 42.8 | 688.7 | 52.81 | 780 | 42.61 | 667.3 |
| 42.68 | 645.6 | 46.6 | 726.6 | 100.0 | 1204 | 46.7 | 707.3 |
| 49.18 | 711.3 | 49.5 | 754.6 | | | 49.51 | 746.3 |
| 52.0 | 731.8 | 100.0 | 1204. | | | 51.35 | 763.3 |

Results at 20° for mixtures of Phosgene and:

| Dichloro Ethylene $C_2H_2Cl_2$ | | Tetrachloro Ethane $C_2H_2Cl_4$ | | Carbon Tetrachloride $CCl_4$ | | Gasoline (Petrol) | |
|---|---|---|---|---|---|---|---|
| Wt. % $COCl_2$ in Solution | Total Vapor Pressure | Wt. % $COCl_2$ in Solution | Total Vapor Pressure | Wt. % $COCl_2$ in Solution | Total Vapor Pressure | Wt. % $COCl_2$ in Solution | Total Vapor Pressure |
| 0.0 | 52 | 0.0 | 7.25 | 0.0 | 89 | 0. | 5 |
| 2.0 | 98 | 5.7 | 137.3 | 5.4 | 226.8 | 9.34 | 260 |
| 7.8 | 210 | 15.44 | 328.3 | 14.95 | 410.8 | 17.57 | 432 |
| 12.7 | 300 | 30.3 | 554.3 | 19.77 | 478.8 | 24.73 | 557 |
| 17.8 | 375 | 35.9 | 627.3 | 29.67 | 621.8 | 30.7 | 654 |
| 22.05 | 438 | 38.5 | 659.3 | 35.45 | 685.8 | 35.91 | 723 |
| 27.1 | 506 | 42.3 | 696 | 40.21 | 733.8 | 40.56 | 760 |
| 33.6 | 597 | 45.02 | 747.3 | 100. | 1204. | 100. | 1204 |
| 36.4 | 648 | 100.0 | 1204. | | | | |
| 39. | 678 | | | | | | |
| 42.93 | 721 | | | | | | |

The authors also give the partial vapor pressures and interpolated vapor pressure values for regular intervals of $COCl_2$ concentration in the several solvents.

**CARBON DISULFIDE** $CS_2$. (See also Vol. I pages 238 and 584.)

100 gms. sat. solution of $CS_2$ in Water contain 0.127 gm. $CS_2$ at 10° and 0.1185 gms. at 25°.

100 gms. sat. solution of $H_2O$ in $CS_2$ contain 0.0086 gm. $H_2O$ at 10° and 0.0142 gm. at 25°. (Uspenski, 1929.)

The complete temperature-concentration diagram of the system $CS_2$ + $H_2O$ between -70 and +135° is given by Terres and Rühl (1934)

RECIPROCAL SOLUBILITY OF CARBON DISULFIDE AND METHYL ALCOHOL.
(Drucker, 1923.)

| t° | Gms. $CS_2$ per 100 gms. sat. sol. | t° | Gms. $CS_2$ per 100 gms. sat. sol. | t° | Gms. $CS_2$ per 100 gms. sat. sol. |
|---|---|---|---|---|---|
| 13.02 | 46.58 | 40.50 | 76.88 | 39.19 | 89.03 |
| 24.77 | 52.55 | 40.6 * | 80.5 | 37.75 | 91.14 |
| 33.12 | 61.42 | 40.69 | 80.75 | 33.44 | 94.73 |
| 39.57 | 71.36 | 40.27 | 83.30 | 23.23 | 97.18 |

* = critical solution temperature. This temperature is given by Cornish, Archibald, Murphy and Evans, 1934, as 36.2°.

RECIPROCAL SOLUBILITY OF CARBON DISULFIDE AND:
(Joukovsky, 1934.)

Acetonitrile ($CH_3CN$)

| t° | Gms. $CS_2$ per 100 gms. mixture | t° | Gms. $CS_2$ per 100 gms. mixture |
|---|---|---|---|
| 3.2 | 26.9 | 51.5* | 62.5 |
| 20.0 | 29.0 | 51.5 | 71.5 |
| 22.0 | 30.3 | 51.5 | 75.2 |
| 38.0 | 35.6 | 49.0 | 83.7 |
| 48.5 | 42.5 | 30.0 | 94.3 |
| 51.5 | 57.8 | 12.5 | 97.5 |

Nitromethane ($CH_3NO_2$)

| t° | Gms. $CS_2$ per 100 gms. mixture | t° | Gms. $CS_2$ per 100. gms. mixture |
|---|---|---|---|
| 18.5 | 14.5 | 63.5* | 55.0 |
| 19.5 | 15.0 | 63.5 | 62.7 |
| 26.5 | 16.0 | 61.5 | 78.4 |
| 33.6 | 17.0 | 57.7 | 84.1 |
| 58.5 | 27.5 | 43.0 | 92.2 |
| 63.4 | 42.4 | 22.5 | 95.5 |

* = Critical solution temperature. (This is given as 63.3° by Timmermans and Mme. Hennaut-Roland, 1932.)

The author also gives results for the total and partial vapor pressures at 20.5° of the above systems and for $CS_2$ + allyl iso sulfocyanide and $CS_2$ + tri ethyl amine.

RECIPROCAL SOLUBILITY OF CARBON DISULFIDE AND ACETONE.
(Wieth, 1929.)

| t° | Gms. per 100 gms. sat. sol. $(CH_3)_2CO$ | Gms. per 100 gms. sat. sol. $CS_2$ | t° | Gms. per 100 gms. sat. sol. $(CH_3)_2CO$ | Gms. per 100 gms. sat. sol. $CS_2$ |
|---|---|---|---|---|---|
| -72 | 78.4 | 21.6 | -42.5 | 41.2 | 58.8 |
| -52 | 61.8 | 38.2 | -45 | 28.7 | 71.3 |
| -43.5 | 51.4 | 48.6 | -55 | 14.8 | 85.2 |
| -42.5 | 46.0 | 54.0 | | | |

## Equilibrium in the Liquid and Vapor Phases of Systems Composed of Carbon Disulfide and Another Solvent.

(Lewin, 1930.)

The determinations were made with the aid of a separatory funnel having a small bulb below the stop-cock and a similar one connected by a short tube with the stopper. The mixture was placed in the lower bulb and the funnel evacuated. The stop-cock was then opened and the mixture allowed to come to equilibrium with its vapor at a given temperature. The stop-cock was then closed, the funnel inverted and the vapor condensed in the bulb of the stopper by means of a freezing mixture. The composition of the two liquid mixtures thus obtained was determined by means of a Pulfrisch refractometer.

Results for mixtures of $CS_2$ and:

Acetone at 35°.10

| Mol. Percent $CS_2$ in | |
|---|---|
| Liquid | Vapor |
| 3.55 | 16.77 |
| 7.96 | 24.46 |
| 12.90 | 36.34 |
| 27.15 | 51.44 |
| 35.85 | 55.90 |
| 49.13 | 60.76 |
| 50.80 | 62.13 |
| 65.01 | 65.77 |
| 83.65 | 74.64 |
| 92.68 | 83.93 |
| 97.17 | 91.73 |

Ether at 20°.10

| Mol. Percent $CS_2$ in | |
|---|---|
| Liquid | Vapor |
| 10.35 | 10.50 |
| 23.20 | 21.70 |
| 31.26 | 28.60 |
| 31.95 | 29.30 |
| 46.65 | 40.01 |
| 59.38 | 48.68 |
| 70.60 | 57.00 |
| 77.60 | 63.60 |
| 83.25 | 69.41 |
| 87.90 | 76.28 |
| 95.60 | 89.70 |

Cyclohexane at 30.05°

| Mol. Percent $CS_2$ in | |
|---|---|
| Liquid | Vapor |
| 6.60 | 16.86 |
| 14.00 | 32.78 |
| 24.42 | 47.64 |
| 36.48 | 60.25 |
| 48.33 | 69.84 |
| 56.35 | 76.45 |
| 62.15 | 79.00 |
| 69.65 | 83.82 |
| 86.55 | 93.90 |

Iso butyl Chloride at 20°

| Mol. Percent $CS_2$ in | | Mol. Percent $CS_2$ in | |
|---|---|---|---|
| Liquid | Vapor | Liquid | Vapor |
| 7.15 | 18.98 | 56.15 | 73.23 |
| 13.73 | 32.71 | 67.72 | 79.25 |
| 24.03 | 46.23 | 83.25 | 88.45 |
| 27.97 | 52.50 | 87.87 | 91.47 |
| 30.30 | 55.25 | 93.45 | 94.95 |
| 42.74 | 65.87 | | |

Iso pentane at 20°.

| Mol. Percent $CS_2$ in | | Mol. percent $CS_2$ in | |
|---|---|---|---|
| Liquid | Vapor | Liquid | Vapor |
| 9.85 | 9.05 | 65.61 | 46.46 |
| 18.30 | 16.52 | 80.90 | 59.43 |
| 32.02 | 26.00 | 82.50 | 61.27 |
| 46.96 | 34.69 | 92.95 | 75.23 |
| 53.85 | 38.80 | 97.90 | 89.83 |

Freezing-point data are given for the following systems:

| | | |
|---|---|---|
| $CS_2$ + $(CH_3COO)_2O$ | (Acetic anhydride) | (Jones and Betts, 1928.) |
| " + $CH_3COOH$ | | (Pickering, 1893.) |
| " + $HCONH_2$ | Formamide | (Jankovsky, 1934.) |
| " + $N(C_2H_5)_3$ | Triethyl amine | " " |
| " + $(C_2H_5)_2O$ | Ethyl Ether | (Saphir, 1929.) |
| " + $CH_3COOC_2H_5$ | " Acetate | " " |
| " + $CH_2(OCH_3)_2$ | Methylal | " " |
| " + $C_5H_{12}$ | Iso pentane | " " |
| " + $CHCl_3$ | Chloroform | (Timmermans, 1928.) |
| " + $CCl_4$ | Carbon tetra chloride | " " |
| " + $C_6H_6$ | Benzene | (Pickering, 1893; Hirshberg, 1932.) |
| " + $C_6H_{12}$ | Cyclohexane | (Hirshberg, 1932.) |
| " + $C_6H_5NO_2$ | Nitrobenzene | (Timmermans, 1928.) |
| " + $C_6H_{11}CH_3$ | Methyl cyclo hexane | (Timmermans, 1934.) |
| " + $C_2H_5Br$ | Ethyl bromide | " " |
| " + $C_4H_9Br$ | Iso butyl bromide | " " |
| " + $(CH_2Cl)_2$ | 1.2 Ethylene chloride | (Hammick and Howard, 1932.) |

**BROMOFORM** $CHBr_3$.

1000 gms. $H_2O$ dissolve 3.01 gms. $CHBr_3$ at 15° and 3.19 gms. at 30°. (Gross and Saylor, 1931.)

100 gms. anhydrous formic acid dissolve 25.3 gms. $CHBr_3$ at 25°. (Gordon and Reid, 1922.)

Freezing-points of Mixtures of:

Bromoform and Liquid Carbon Dioxide.
(Büchner, 1905–06.)

| t°. | Gms. $CHBr_3$ per 100 Gms. $CH_3Br+CO_2$. |
|---|---|
| −31 | 0 |
| −32 | 3.7 |
| −30 | 4.9 |
| −16 | 13.5 |
| − 8 | 24 |
| − 5 | 35.2–67.7 quad. pt. |
| − 3.5 | 92.1 |

Bromoform and Toluene.
(Baud, 1912.)

| t° of Freezing. | Gms. $CHBr_3$ per 100 Gms. $CHBr_3+C_6H_5.CH_3$. | Solid Phase. |
|---|---|---|
| + 7.7 | 100 | $CHBr_3$ |
| −11.4 | 86.6 | " |
| −22.2 | 75.6 | " |
| −30.9 | 69.8 | " |
| −48.5 | 60.3 | " |

Freezing-point lowering data are also given for:

$CHBr_3 + NO_2$ (Pascal, 1923.)
" $+ C_6H_6$ (Schmidlin and Lang, 1912.)

**CHLOROFORM** $CHCl_3$.

Solubility in Water.
(Chancel and Parmentier, 1885; Rex, 1906.)

| t°. | Gms. $CHCl_3$ per Liter of Solution. | Density of Solutions. | t°. | Gms. $CHCl_3$ per 100 Gms. $H_2O$ (Rex). |
|---|---|---|---|---|
| 0 | 9.87 | 1.00378 | | |
| 3.2 | 8.90 | ... | 0 | 1.062 |
| 17.4 | 7.12 | 1.00284 | 10 | 0.895 |
| 29.4 | 7.05 | 1.00280 | 20 | 0.822 |
| 41.6 | 7.12 | 1.00284 | 30 | 0.776 |
| 54.9 | 7.75 | 1.00309 | | |

100 cc. $H_2O$ dissolve 0.42 cc. $CHCl_3$ at 22°; Vol. of sol. = 100.39 cc., Sp. Gr. = 1.0002.

100 cc. $CHCl_3$ dissolve 0.152 cc. $H_2O$ at 22°; Vol. of sol. = 99.62 cc., Sp. Gr. = 1.4831. (Herz, 1898.)

1000 gms. $H_2O$ dissolve 8.52 gms. $CHCl_3$ at 15° and 7.71 gms. at 30°. (Gross and Saylor, 1931.)

## Solubility of Water in Chloroform. (See also Vol. I, p.584.)

(Gibby and Hall, 1931.)

Mixtures of accurately weighed amounts of water and chloroform were warmed until the water dissolved and, while cooling, the temperature determined at which the first appearance of turbidity could be detected by observing from the side in a beam of light. The results when plotted give two lines which intersect at 0°, the point corresponding to the change from the solubility of ice to that of water. The authors failed to obtain the hydrate of chloroform reported by Chancel and Parmentier, 1885.

| t° | Gms. $H_2O$ per 100 gms. $H_2O$ + $CHCl_3$ | t° | Gms. $H_2O$ per 100 gms. $H_2O$ + $CHCl_3$ | t° | Gms. $H_2O$ per 100 gms. $H_2O$ + $CHCl_3$ |
|---|---|---|---|---|---|
| -25 | 0.006(1) | 11 | 0.043 | 31 | 0.109 |
| -15 | 0.009(1) | 17 | 0.061 | 45 | 0.118 |
| -1 | 0.014(1) | 22 | 0.065 | 43 | 0.144 |
| +3 | 0.019 | 23 | 0.072 | 54 | 0.165 |

(1) = Solid Phase, Ice.

100 cc 2.0 normal aq. sodium acetate solution dissolve 0.4 gm. $CHCl_3$ at about 18°. (Traube, Schöning and Weber, 1927.)

100 gms. aqueous 0.4 normal sodium oleate solution (=10.8 gms. Na oleate per 100 gms. solution) dissolve 20.6 gms. $CHCl_3$ at 20°. (Smith, 1932.)

## Solubility of Chloroform in Water and in Blood.

(Winterstein and Hirschberg, 1927.)

The solutions were saturated both by shaking with an excess of $CHCl_3$ and by passing a current of air saturated with $CHCl_3$ vapor through or above the solution until saturated.

| Solvent | t° | Gms. $CHCl_3$ per 100 gms. sat. sol. |
|---|---|---|
| Water | 16-18 | 0.55 |
| Physiol. salt sol. (0.85% NaCl) | " | 0.50 |
| Unchanged blood serum | " | 0.56-0.77 |
| Whole blood | " | 0.75-0.86 |

The distribution of chloroform between blood corpuscles and blood liquid depends upon the concentration of $CHCl_3$. At concentrations near the saturation point the corpuscles absorb about twice as much as the plasma while at very low concentrations the corpuscles can absorb four to six times as much $CHCl_3$ as the plasma.

## Solubility of Chloroform in Aqueous Ethyl Alcohol, Methyl Alcohol, and Acetone Mixtures at 20°.

(Bancroft, 1895.)

| In Ethyl Alcohol. Per 5 cc. $C_2H_5OH$. | | In Methyl Alcohol. Per 5 cc. $CH_3OH$. | | In Acetone. Per 5 cc. $(CH_3)_2CO$ | |
|---|---|---|---|---|---|
| cc. $H_2O$. | cc. $CHCl_3$. | cc. $H_2O$. | cc. $CHCl_3$. | cc. $H_2O$. | cc. $CHCl_3$. |
| 10 | 0.20 | 10 | 0.10 | 5 | 0.16 |
| 8 | 0.3 | 5 | 0.48 | 4 | 0.22 |
| 6 | 0.515 | 4 | 0.8 | 3 | 0.33 |
| 4 | 1.13 | 2 | 4 | 2 | 0.58 |
| 2 | 2.51 | 1.49 | 7 | 1 | 0.955 |
| 1 | 4.60 | 1.35 | 8 | 0.79 | 1.12 |
| 0.91 | 5 | 1.12 | 10 | 0.505 | 1.60 |
| 0.76 | 6 | | | 0.30 | 2.50 |
| 0.55 | 8 | | | 0.21 | 3.50 |
| 0.425 | 10 | | | 0.19 | 4 |
| 0.20 | 20 | | | 0.16 | 5 |
| 0.125 | 30.24 | | | 0.12 | 10 |

Data for the system chloroform, ethyl ether and water are given by Jüttner, 1901.

Experiments by Schachner (1910) show that various fats (olive oil, sheep suet, goose fat) in an atmosphere containing 0.55% $CHCl_3$ vapor, dissolve 0.96–0.98 per cent $CHCl_3$ at 38.5°.

Data for the properties of solutions of $CHCl_3$ in water, saline solution, serum, hemoglobin, etc., in their relation to anesthesia are given by Moore and Roaf, (1904) and Waller (1904–05).

## Equilibrium in the System Chloroform, Ethyl Alcohol and Water.

(Schoorl and Regenbogen, 1922.)

Mixtures of accurately measured volumes of the very carefully purified constituents were cooled to the appearance of milkiness and the temperature measured by a thermometer immersed in the mixture. The determinations were plotted and the following results for regular intervals of temperature obtained from the curves.

| Ratio in cc. of $H_2O$ to $C_2H_5OH$. | | Cc. $CHCl_3$ required to yield clouding at | | | | | |
|---|---|---|---|---|---|---|---|
| | | 0°. | 10°. | 15°. | 20°. | 25°. | 66°. |
| 80 | 20 | – | 0.7 | – | – | – | – |
| 66.7 | 33.3 | 0.7 | 1.0 | 1.3 | 1.6 | 1.9 | – |
| 60 | 40 | 1.5 | 2.2 | 2.5 | 2.9 | 3.2 | – |
| 50 | 50 | 6.35 | 7.6 | 8.2 | 8.9 | 9.6 | 14.0 |
| 33.3 | 66.7 | 20.8 | 22.9 | 23.9 | 24.9 | 25.9 | – |

| Ratio in cc. of $CHCl_3$ to $C_2H_5OH$. | | Cc. $H_2O$ required to yield clouding at | | | | | |
|---|---|---|---|---|---|---|---|
| | | 0°. | 10°. | 15°. | 20°. | 25°. | 66°. |
| 33.3 | 66.7 | 20.1 | 22.3 | 23.4 | 24.4 | 25.5 | – |
| 50.0 | 50.0 | 8.8 | 9.7 | 10.2 | 10.6 | 11.1 | 14.5 |
| 69.0 | 31.0 | 3.4 | 3.65 | 3.8 | 3.95 | 4.15 | – |
| 81.0 | 19.0 | 1.4 | 1.5 | 1.6 | 1.65 | 1.7 | – |

For a mixture of 50 cc. of $H_2O$ + 50 cc. $CHCl_3$, 45 cc. $C_2H_5OH$ are required to yield clouding at 66°.

It is pointed out that the difference between the present results and those of Bancroft are easily explained if Bancroft used alcohol containing 6 % $H_2O$, instead of absolute.

## CHLOROFORM $CHCl_3$.

### Solubility of Chloroform in Organic Solvents at 32.2°.

(Zellhoeffer, Copley and Marvel, 1938.)

| Solvent | Formula | Gms. $CHCl_3$ per 100 gms. solvent(1) |
|---|---|---|
| Ethyl ether of di ethylene glycol acetate | $C_2H_5O(CH_2CH_2O)_2COCH_3$ | 80.0 |
| Di methyl ether of tetra ethylene glycol | $CH_3O(CH_2CH_2O)_4CH_3$ | 89.5 |
| Di ethyl ether of diethylene glycol | $C_2H_5O(CH_2CH_2O)_2C_2H_5$ | 87.5 |

(1) At a pressure of $CHCl_3$ corresponding to its vapor pressure at 4.5°.

### Freezing-Points of Mixtures of Chloroform and Ethyl Ether:

(Smits and Berckmans, 1918.)

| t° of freezing. | Mols $CHCl_3$ per 100 mols. mixture. | Solid Phase. | t° of freezing. | Mols $CHCl_3$ per 100 mols. mixture. | Solid Phase. |
|---|---|---|---|---|---|
| −66.5..... | 100.0 | $CHCl_3$ | − 95.8..... | 45.13 | $CHCl_3.(C_2H_5)_2O$ |
| −72.6..... | 90.04 | » | − 99.7..... | 40.00 | » |
| −78.7..... | 81.77 | » | −104.8..... | 35.00 | » |
| −93.5..... | 70.00 | » | −108.1..... | 33.33 | » |
| −95.2 (Eutec.). | - | » +$2CHCl_3.(C_2H_5)_2O$ | −111.4..... | 30.05 | $CHCl_3.2(C_2H_5)_2O$ |
| −93.6..... | 68.00 | $2CHCl_3.(C_2H_5)_2O$ | −114.3..... | 27.0 | » |
| −93.5..... | 66.66 | » | −117.6..... | 20.0 | » |
| −93.6..... | 65.00 | » | −118.4..... | 18.65 | » |
| −96.0..... | 61.00 | » | −121.5..... | 14.99 | » |
| −97.4 (Eutec.). | - | » + $CHCl_3.(C_2H_5)_2O$ | −121.7 (Eutec.). | - | » + $(C_2H_5)_2O$ |
| −96.4..... | 60.0 | $CHCl_3.(C_2H_5)_2O$ | −119.9..... | 10.01 | $(C_2H_5)_2O$ |
| −95.1..... | 55.0 | » | −118.3..... | 5.13 | » |
| −94.4..... | 50.0 | » | −116.4..... | 0.00 | » |

Freezing-point data for mixtures of chloroform and nitrogen peroxide are given by Pascal, 1923.

### Mutual Solubility of Benzene and Chloroform. Freezing-point Method. (Wroczynski and Guye, 1910.)

| t°. | Gms. $C_6H_6$ per 100 Gms. Solution. | Solid Phase. | t°. | Gms. $C_6H_6$ per 100 Gms. Solution. | Solid Phase. | t°. | Gms. $C_6H_6$ per 100 Gms. Solution. | Solid Phase. |
|---|---|---|---|---|---|---|---|---|
| −63.5 | 0 | $CHCl_3$ | −60 | 26.8 | $C_6H_6$ | −20 | 58.3 | $C_6H_6$ |
| −70 | 11.8 | " | −50 | 32 | " | −10 | 70.8 | " |
| −75 | 14.7 | " | −40 | 39 | " | 0 | 88 | " |
| −81.7 | 18.4 | $CHCl_3+C_6H_6$ | −30 | 47.8 | " | 5 | 100 | " |
| −70 | 22.6 | $C_6H_6$ | | | | | | |

The eutectic point was found by extending the curves to their intersection. The temperature of the eutectic could not be reached by use of liquid $CO_2$.

### Distribution of Chloroform Between Methyl Alcohol and Oil of Vaseline at 25°.

(Kozakewitch, 1935.)

| Gm. Mol. $CHCl_3$ per 1000 gms: $CH_3OH$(a) | Vaseline(v) | $\frac{a}{v}$ | Gm. Mol. $CHCl_3$ per 1000 gms: $CH_3OH$(a) | Vaseline(v) | $\frac{a}{v}$ |
|---|---|---|---|---|---|
| 0.337 | 0.068 | 5.1 | 0.589 | 0.126 | 4.7 |
| 0.389 | 0.0861 | 4.4 | 0.630 | 0.117 | 5.3 |
| 0.482 | 0.0935 | 4.4 | | | |

The author also gives results showing the effect of various salts upon the above distribution.

Freezing-point data are given for:

$CHCl_3$+$CCl_4$ (Carbon tetrachloride)(1)(6)
" +$CS_2$ (Carbon di sulfide)(1)
" +$CH_3OH$(Methyl alcohol)(2)(4)(10)
" +$(CH_3)_2CO$ (Acetone)(3)(5)
" +$(CH_3)_2O$ (Methyl Ether)(9)
" +$(C_2H_5)_2O$ (Ethyl Ether)(4)
" +$C_6H_6$ (Benzene)(1)(3)(7)

$CHCl_3$+$C_6H_5NH_2$ (Aniline)(5)
" +$C_6H_5CH_3$ (Toluene)(1)
" +$C_6H_5NO_2$ (Nitrobenzene)(8)
" +$C_6H_{12}$ (Cyclohexane)(1)
" +$C_6H_{14}$ n (Hexane)(1)
" +HBr(11)
" +HCl(10)

(1) Timmermans, 1928; (2) Saphir, 1929; (3) Wyatt, 1928; (4) Wyatt, 1929; (5) Tsakalatos and Guye, 1910; (6) Sameshima and Hiramatsu, 1934; (7) Wroczynskii and Guye, 1910; (8) Hyrnakowski and Szmyt, 1928; (9) Baume, 1909, 1914; (10) Baume and Borowski, 1914; (11) Maass and McIntosh, 1912.

## DICHLORO MONO BROMO METHANE $CHCl_2Br$.

A saturate solution of dichloro brom methane in formic acid contains 76 percent $CHCl_2Br$ at 61.3°. (Lecat, 1930.)

## DICHLORO MONOFLURO METHANE $CHCl_2F$.

SOLUBILITY OF DICHLORO MONOFLUORO METHANE IN ORGANIC SOLVENTS AT 32.2°.
(Copley, Zellhoeffer and Marvel, 1938.)

| Solvent | Formula | Gms. $CHCl_2F$ per 100 gms. solvent(1) | Mol. fraction |
|---|---|---|---|
| Phenol | $C_6H_5OH$ | 26.9 | 0.197 |
| Ethylene Glycol | $HOCH_2CH_2OH$ | 10.0 | 0.055 |
| Tri methylene Glycol | $HOCH_2CH_2CH_2OH$ | 10.6 | 0.073 |
| Anisole | $C_6H_5OCH_3$ | 67.3 | 0.415 |
| Phenetole | $C_6H_5OC_2H_5$ | 62.5 | 0.425 |
| Phenyl vinyl ether | $C_6H_5OCH=CH_2$ | 55.9 | 0.394 |
| Dimethyl ether of ethylene glycol | $CH_3OCH_2CH_2OCH_3$ | 155.0 | 0.576 |
| Cyclohexyl methyl ether | $(CH_2)_5CHOCH_3$ | 90.0 | 0.500 |
| 1.4-Dimethoxy cyclo hexane | $CH_3OHC(CH_2)_4CHOCH_3$ | 94.1 | 0.571 |
| Acetic acid | $CH_3COOH$ | 68.8 | 0.286 |
| Propionic acid | $C_2H_5COOH$ | 66.5 | 0.330 |
| n Butyl butyrate | $CH_3(CH_2)_2COO(CH_2)_3CH_3$ | 87.0 | 0.546 |
| Diethyl oxalate | $C_2H_5OCOCOOC_2H_5$ | 56.1 | 0.556 |
| Dimethyl sulfate | $(CH_3O)_2SO_2$ | 46.3 | 0.361 |
| Tri ethyl phosphate | $(C_2H_5O)_3PO_4$ | 113.2 | 0.666 |
| Tri butyl phosphate | $(C_4H_9O)_3PO_4$ | 84.2 | 0.685 |
| Tri ($\beta$-methoxyethyl) phosphate | $(CH_3OCH_2CH_2O)_3PO_4$ | 83.6 | 0.687 |
| Cyclo hexyl amine | $CH_2(CH_2)_4CHNH_2$ | 107.0 | 0.506 |
| Aniline | $C_6H_5NH_2$ | 38.5 | 0.258 |
| Quinoline | $C_9H_7N$ | 63.3 | 0.443 |
| Dimethyl cyclo hexyl amine | $CH_2(CH_2)_4CHN(CH_3)_2$ | 80.7 | 0.500 |
| Dimethyl aniline | $C_6H_5N(CH_3)_2$ | 69.5 | 0.425 |
| Methyl diphenyl amine | $(C_6H_5)_2NCH_3$ | 35.7 | 0.388 |
| Formamide | $HCONH_2$ | 7.5 | 0.032 |
| Acetamide | $CH_3CONH_2$ | trace | — |
| Methyl formamide | $HCONHCH_3$ | 76.8 | 0.303 |

| | | | |
|---|---|---|---|
| N, N-Dimethyl formamide | $HCON(CH_3)_2$ | 93.1 | 0.398 |
| N,-Methyl acetamide | $CH_3CONH(CH_3)$ | 95.5 | 0.403 |
| N, N-Dimethyl acetamide | $CH_3CON(CH_3)_2$ | 187.0 | 0.614 |
| N,- Tetra ethyloxamide | $[CON(C_2H_5)_2]_2$ | 96.5 | 0.651 |
| N, N-Tetra methyl succinamide | $[CH_2CON(CH_3)_2]_2$ | 118.0 | 0.663 |
| N, Methyl-N-cyclohexyl acetamide | $CH_3CON(CH_3)C_6H_{10}$ | 114.0 | 0.632 |
| Benzaldehyde | $C_6H_5CHO$ | 75.0 | 0.436 |
| Heptaldehyde | $C_6H_{13}CHO$ | 97.9 | 0.510 |
| Paraldehyde | $C_6H_{12}O_3$ | 88.8 | 0.532 |
| Cyclohexanone | $CH_2(CH_2)_4C{=}O$ | 127.8 | 0.548 |
| $\Delta^2$-Cyclohexanone | $CH_2\langle{}^{CH_2-CH_2}_{CH=CH}\rangle C{=}O$ | 90.3 | 0.457 |
| Acetyl acetone | $CH_2C{=}O.CH_2C{=}O.CH_3$ | 102.3 | 0.499 |
| Acetonyl acetone | $CH_3.C{=}O.CH_2CH_2.C{=}O.CH_3$ | 116.3 | 0.563 |
| Ethyl aceto acetate | $CH_3C{=}O.CH_2C{=}O.OC_2H_5$ | 91.3 | 0.536 |
| Ethyl diethyl aceto acetate | $CH_3C{=}O.C(C_2H_5)_2C{=}O.OC_2H_5$ | 88.0 | 0.614 |
| Salicyl aldehyde | $C_6H_4OHCHO$ | 50.1 | 0.372 |
| Ethyl'methyl ketoxime | $CH_3C{=}NOH.C_2H_5$ | 65.0 | 0.338 |

(1) At a partial pressure of di chloro mono fluoro methane corresponding to its vapor pressure (0.847 atm.) at 4.5°. The vapor pressure of this compound is 2.221 atmospheres at 32.2°. The theoretical "Ideal" Mol. fraction is 0.381 in the saturated solution. This was calculated by using Raoult's law, and is the ratio of the vapor pressure of di chloro mono fluoro methane at 4.5° to its value at 32.2°.

SOLUBILITY OF DICHLORO MONOFLUORO METHANE IN ORGANIC SOLVENTS AT 32°.
(Zellhoeffer, 1937.)

| Solvent | Formula | Gms. $CHCl_2F$ per 100 cc solvent at 638 mm pressure(1) |
|---|---|---|
| Cellosolve acetate | $C_2H_5O(CH_2)_2OCOCH_3$ | 100.0 |
| Carbitol acetate | $C_2H_5O(CH_2CH_2O)_2COCH_3$ | 97.0 |
| Carbitol ethyl ether | $C_2H_5O(CH_2CH_2O)_2C_2H_5$ | 105.0 |
| Dimethyl ether of tetraethyleneglycol | $CH_3O(CH_2CH_2O)_4CH_3$ | 104.0 |
| Diethyl ether of tetraethylene glycol | $C_2H_5O(CH_2CH_2O)_4C_2H_5$ | 93.0 |
| Dimethyl ether of triethylene glycol | $[CH_3O(CH_2)_2OCH_2]_2$ | 98.0 |
| Carbitol methoxyacetate | $C_2H_5O(CH_2CH_2O)_2COCH_2OCH_3$ | 89.0 |
| Butyl carbitol acetate | $\underline{n}\ C_4H_9O(CH_2CH_2O)_2COCH_3$ | 70.0 |
| Diethylene glycol diacetate | $[CH_3COOCH_2CH_2]_2O$ | 88.0 |
| 4- Methyl-2-pentanol acetate | $(CH_3)_2CHCH_2CH(OCOCH_3)CH_3$ | 72.0 |
| 2,3-Di-β'-ethoxy-β-ethoxydioxane | $C_{12}H_{24}O_6$ | 85.0 |
| y,y'-Dichloro-n-propyl ether | $(ClCH_2CH_2CH_2)_2O$ | 49.0 |
| Dichloro isopropyl ether | $(C_3H_6Cl)_2O$ | 49.0 |
| α Fluoro naphthalene | $C_{10}H_7F$ | 37.0 |
| Butyl cellosolve n butyrate | $\underline{n}\ C_4H_9O(CH_2)_2OO\text{-}\underline{n}\text{-}C_3H_7$ | 65.0 |
| Butyl cellosolve acetate | $\underline{n}\ C_4H_9O(CH_2)_2OCOCH_3$ | 75.0 |

## DICHLORO MONOFLUORO METHANE $CHCl_2F$. (Con.)

### Solubility of Dichloro Monofluoro Methane in Organic Solvents at 32 . (Con.)

| Solvent | Formula | Gms. $CHCl_2F$ per 100 cc solvent at 638 mm pressure(1) |
|---|---|---|
| Butyl cellosolve laurate | $\underline{n}\ C_4H_9O(CH_2)_2OCO(CH_2)_{10}CH_3$ | 44.0 |
| Butyl cellosolve tetra hydro furfuryl ether | $(C_4H_9O)CH_2O(CH_2)_2O\ \underline{n}C_4H_9$ | 75.0 |
| Tetra hydro furfuryl cellosolve acetate | $(C_4H_9O)CH_2O(CH_2)_2OCOCH_3$ | 86.0 |
| Methyl carbitol acetate | $CH_3O(CH_2CH_2O)COCH_3$ | 100.0 |
| Butyl carbitol chloride | $\underline{n}$-$C_4H_9(CH_2CH_2O)_2Cl$ | 63.0 |
| Methyl ether of triethylene glycol acetate | $CH_3O(CH_2CH_2O)_3COCH_3$ | 91.0 |
| Tetra hydro furfuryl laurate | $(C_4H_7O)CH_2OCO(CH_2)_{10}CH_3$ | 50.0 |
| Tetra hydro furfuryl acetate | $(C_4H_7O)CH_2OCOCH_3$ | 87.0 |
| $\alpha\gamma$,Glycerol dichlor hydrine acetate | $(ClCH_2)_2CHOCOCH_3$ | 55.0 |
| Ethyl laurate | $CH_3(CH_2)_{10}COOC_2H_5$ | 48.0 |
| 2-Ethyl-1-hexanol acetate | $CH_3(CH_2)_3CH(C_2H_5)CH_2OCOCH_3$ | 63.0 |
| Furfuryl acetate | $(C_4H_3O)CH_2OCOCH_3$ | 65.0 |
| Ethyl furonate | $(C_4H_3O)COOC_2H_5$ | 76.0 |
| Furfural | $(C_4H_3O)CHO$ | 72.0 |
| Tetralin | $C_{10}H_{12}$ | 46.0 |
| Decalin | $C_{10}H_{18}$ | 24.0 |
| Benzo trifluoride | $C_6H_5CF_3$ | 40.0 |
| p Fluoro anisole | $p\ FC_6H_4OCH_3$ | 56.0 |
| Cellosolve glycollate | $C_2H_5O(CH_2)_2OCOCH_2OH$ | 57.0 |
| Cellosolve succinate | $[C_2H_5O(CH_2)_2OCOCH_2]_2$ | 70.0 |
| Cellosolve adipate | $[C_2H_5O(CH_2)_2OCO(CH_2)_2]_2$ | 75.0 |
| Benzyl cellosolve | $C_6H_5CH_2O(CH_2)_2OH$ | 42.0 |
| Benzyl cellosolve acetate | $C_6H_5CH_2O(CH_2)_2OCOCH_3$ | 65.0 |
| Methyl cellosolve phthalate | $o\ C_6H_4(COOCH_2CH_2OCH_3)_2$ | 59.0 |
| Butyl cellosolve phthalate | $o\ C_6H_4(COOCH_2CH_2O\text{-}n\text{-}C_4H_9)_2$ | 51.0 |
| Ethylene glycol diacetate | $(CH_3COOCH_2)_2$ | 91.0 |
| Methyl cellosolve carbonate | $(CH_3OCH_2CH_2O)_2CO$ | 77.0 |
| Carbitol levulinate | $C_2H_5O(CH_2CH_2O)_2CO(CH_2)_2COCH_3$ | 75.0 |
| Ethylene glycol diethoxy acetate | $(C_2H_5OCH_2COOCH_2)_2$ | 75.0 |
| Diethylene glycol diethoxy acetate | $[C_2H_5OCH_2COOCH_2CH_2]_2O$ | 71.0 |
| Carbitol ethoxy acetate | $C_2H_5O(CH_2CH_2O)_2COCH_2OC_2H_5$ | 84.0 |
| Diethylene glycol dimethoxy acetate | $[CH_3OCH_2COOCH_2CH_2]_2O$ | 71.0 |
| Methylene carbitol methoxy acetate | $CH_3O(CH_2CH_2O)_2COCH_2OCH_3$ | 93.0 |
| Methyl carbitol chloride | $CH_3(CH_2CH_2O)_2Cl$ | 80.0 |
| Ditetra hydro furfuryl ether of diethylene glycol | $[C_4H_7O)CH_2OCH_2CH_2]_2O$ | 86.0 |
| Tetra hydro furfuryl cellosolve acetate | $(C_4H_7O)CH_2OCH_2CH_2OCOCH_3$ | 86.0 |
| Triethylene glycol dimethoxy acetate | $(CH_2OCH_2COOCH_2CH_2OCH_2)_2$ | 72.0 |
| Di-$\beta$-chloroethyl ether of ethylene glycol | $[ClCH_2CH_2OCH_2]_2$ | 54.0 |
| Methoxy acetate of triethylene glycol acetate | $CH_2OCH_2COO(CH_2CH_2O)_2COCH_3$ | 89.0 |
| Triethylene glyco diacetate | $[CH_3COOCH_2CH_2OCH_2]_2$ | 85.0 |
| Dimethyl ether of hexa ethylene glycol | $CH_3O(CH_2CH_2O)_6CH_3$ | 88.0 |
| 2,3-Di-$\beta$"methoxy-$\beta$-'-ethoxy-$\beta$- ethoxy dioxane | $C_{14}H_{28}O_8$ | 74.0 |
| Methyl ether of triethylene glycol chloride | $CH_3(CH_2CH_2O)_2Cl$ | 84.0 |

SOLUBILITY OF DICHLORO MONOFLUORO METHANE IN ORGANIC SOLVENTS AT 32.2°. (Con.)
(Zellhoefer, Copley and Marvel, 1938.)

| Solvent | Formula | Gms. $CHCl_2F$ per 100 gms. solvent at 638 mm pressure(1) |
|---|---|---|
| Trimethylene glycol diacetate | $(CH_3COOCH_2)_2CH_2$ | 90.0 |
| Trimethylene glycol dimethoxy acetate | $(CH_3OCH_2COOCH_2)_2CH_2$ | 77.0 |
| Tetra hydro furfuryl methoxy acetate | $(C_4H_7O)CH_2OCOCH_2OCH_3$ | 94.0 |
| Tetra hydro furfuryl benzoate | $(C_4H_7O)CH_2OCOC_6H_5$ | 62.0 |
| Triacetin | $(CH_3COOCH_2)_2CHOCOCH_3$ | 73.0 |
| Tripropionin | $(CH_3CH_2COOCH_2)_2CHOCOCH_2CH_3$ | 67.0 |
| Tributyrin | $[CH_3(CH_2)_2COOCH_2]_2CHOCO(CH_2)_3CH_3$ | 49.0 |
| Tricaproin | $[CH_3(CH_2)_4COOCH_2]_2CHOCO(CH_2)_4CH_3$ | 51.0 |
| Ethylene glycol | $HOCH_2CH_2OH$ | 11.0 |
| Diethylene glycol | $(HOCH_2CH_2)_2O$ | 32.0 |
| Triethylene glycol | $HO(CH_2CH_2O)_3H$ | 40.0 |
| Trimethylene glycol | $HO(CH_2)_3OH$ | 12.0 |
| Tetra hydro furfuryl alcohol | $(C_4H_7O)CH_2OH$ | 62.0 |
| n Butyl-n butyrate | $\underline{n}\ C_3H_7COO\text{-}n\text{-}C_4H_9$ | 76.0 |
| Diethyl phthalate | $\underline{o}\ C_6H_4(COOC_2H_5)_2$ | 65.0 |
| Diethyl acetone dicarboxylate | $(C_2H_5OCOCH_2)_2CO$ | 66.0 |
| Ethyl levulinate | $CH_3CO(CH_2)_2COOC_2H_5$ | 91.0 |
| Resorcinol diethyl ether | $\underline{n}\ C_6H_4(OC_2H_5)_2$ | 52.0 |
| *l* Menthone | $C_{10}H_{18}O$ | 71.0 |
| Diphenyl sulfide | $C_6H_5SC_6H_5$ | 32.0 |
| Ethyl ether of diethylene glycolacetate | $C_2H_5O(CH_2CH_2O)_2COCH_3$ | 102.0 |
| Dimethyl ether of tetra ethylene glycol | $CH_3O(CH_2CH_2O)_4CH_3$ | 111.0 |
| Diethyl ether of diethylene glycol | $C_2H_5O(CH_2CH_2O)_2C_2H_5$ | 113.0 |
| Cyclohexyl methyl ether | $C_6H_{11}OCH_3$ | 90.0 |
| Dimethyl ether of ethylene glycol | $CH_3OCH_2CH_2OCH_3$ | 155.0 |
| Di-β-Chloroethyl ether | $ClCH_2CH_2OCH_2CH_2Cl$ | 42.5 |
| Dimethyl ether of diethylene glycol | $CH_3O(CH_2CH_2O)_2CH_3$ | 120.0 |
| Diethyl ether of diethylene glycol | $C_2H_5O(CH_2CH_2O)_2C_2H_5$ | 113.0 |
| Methyl ether of diethylene glycol chloride | $CH_3(CH_2CH_2O)_3Cl$ | 69.0 |
| Dimethyl ether of triethylene glycol | $CH_3O(CH_2CH_2O)_3CH_3$ | 101.0 |
| Methyl ether of triethylene glycol chloride | $CH_3(CH_2CH_2O)_3Cl$ | 77.5 |
| Dimethyl ether of tetra ethylene glycol | $CH_3O(CH_2CH_2O)_4CH_3$ | 111.0 |
| Dimethyl ether of hexa ethylene glycol | $CH_3O(CH_2CH_2O)_6CH_3$ | 83.6 |
| y,y'-Dichloro-n-propyl ether | $(ClCH_2CH_2CH_2)_2O$ | 43.8 |
| Dichloro-iso propyl ether | $[ClCH_2(CH_3)CH]_2O$ | 44.5 |
| p Fluoro anisole | $\underline{p}\ FC_6H_4OCH_3$ | 50.8 |
| Resorcinol diethyl ether | $\underline{m}\ C_6H_4(OC_2H_5)_2$ | 52.0 |
| Dioxane | $C_4H_8O_2$ | 107.7 |
| Tetra hydro furfuryl ether of $\underline{n}$ butyl cellosolve | $(C_4H_7O)CH_2O(CH_2)_2OC_4H_7$ | 79.1 |

## DICHLORO MONO FLUORO METHANE $CHCl_2F$. (Con.)

SOLUBILITY OF DICHLORO MONOFLUORO METHANE IN ORGANIC SOLVENTS AT 32.2°. (Con.)
(Zellhoefer, Copley and Marvel, 1938.)

| Solvent | Formula | Gms. $CHCl_2F$ per 100 gms. solvent at 638 mm. pressure(1) |
|---|---|---|
| Ditetra hydro furfuryl ether of diethylene glycol | $[(C_4H_7O)CH_2OCH_2CH_2]_2O$ | 80.0 |
| Diphenyl sulfide | $C_6H_5SC_6H_5$ | 28.8 |
| Bis(β-methylthiol ethyl) sulfide | $CH_3SCH_2CH_2SCH_2CH_2SCH_3$ | 46.0 |
| n Butyl butyrate | $CH_3(CH_2)_2COO(CH_2)_3CH_3$ | 87.0 |
| Ethyl laurate | $CH_3(CH_2)_{10}COOC_2H_5$ | 56.1 |
| Diethyl phthalate | o $C_6H_4(COOC_2H_5)_2$ | 56.1 |
| Diethyl oxalate | $C_2H_5OCOCOOC_2H_5$ | 83.0 |
| Diethyl malonate | $C_2H_5OOCCH_2COOC_2H_5$ | 82.0 |
| Triacetin | $(CH_3COOCH_2)_2CHOCOCH_3$ | 62.9 |
| Tripropionin | $(CH_3CH_2COOCH_2)_2CHOCOCH_2CH_3$ | 61.7 |
| Tributyrin | $[CH_3(CH_2)_2COOCH_2]_2CHOCO(CH_2)_2CH_3$ | 45.8 |
| Tricaproin | $[CH_3(CH_2)_4COOCH_2]_2CHOCO(CH_2)_4CH_2$ | 52.1 |
| Trimethylene glycol diacetate | $(CH_3COOCH_2)_2CH_2$ | 84.1 |
| α, γ-Glycerol dichlorhydrin acetate | $(ClCH_2)_2CHOCOCH_3$ | 44.0 |
| 4 - Methyl -2- pentanol acetate | $(CH_3)_2CHCH_2CH(OCOCH_3)CH_3$ | 84.8 |
| Cellosolve acetate | $C_2H_5O(CH_2)_2OCOCH_3$ | 104.0 |
| Cellosolve succinate | $[C_2H_5O(CH_2)_2OOCCH_2]_2$ | 65.0 |
| Cellosolve adipate | $[C_2H_5O(CH_2)_2OOC(CH_2)_2]_2$ | 71.7 |
| Benzyl cellosolve acetate | $C_6H_5CH_2O(CH_2)_2OCOCH_3$ | 60.4 |
| Methyl cellosolve phthalate | o $C_6H_4(COOCH_2CH_2OCH_3)_2$ | 50.5 |
| n Butyl cellosolve phthalate | o $C_6H_4(COOCH_2CH_2OC_4H_9)_2$ | 48.4 |
| Ethylene glycol diethoxy acetate | $(C_2H_5OCH_2COOCH_2)_2$ | 67.0 |
| Diethylene glycol diethoxy acetate | $(C_2H_5OCH_2COOCH_2CH_2)_2O$ | 63.0 |
| Dimethylene glycol dimethoxy acetate | $(CH_3OCH_2COOCH_2CH_2)_2O$ | 60.2 |
| Tetra hydro furfuryl cellosolve acetate | $(C_4H_7O)CH_2OCH_2CH_2OCOCH_3$ | 80.9 |
| Triethylene glycol dimethoxy acetate | $(CH_3OCH_2COOCH_2CH_2OCH_2)_2$ | 61.4 |
| Methoxy acetate of triethylene glycol acetate | $(CH_3OCH_2COO(CH_2CH_2O)_3COCH_3$ | 84.3 |
| Triethylene glycol diacetate | $[CH_3COOCH_2CH_2OCH_2]_2$ | 75.9 |
| Carbitol methoxy acetate | $C_2H_5O(CH_2CH_2O)_2COCH_2OCH_3$ | 81.2 |
| n Butyl carbitol acetate | $C_4H_9O(CH_2CH_2O)_2COCH_3$ | 71.8 |
| Diethylene glycol diacetate | $(CH_3COOCH_2CH_2)_2O$ | 79.2 |
| n Butyl cellosolve n butyrate | $C_4H_9O(CH_2)_2OOCC_3H_7$ | 71.3 |
| n Butyl cellosolve acetate | $C_4H_9O(CH_2)_2OCOCH_3$ | 80.4 |
| n Butyl cellosolve laurate | $C_4H_9O(CH_2)_2OOC(CH_2)_{10}CH_3$ | 49.9 |
| Methyl carbitol acetate | $CH_3O(CH_2CH_2O)_2COCH_3$ | 94.0 |
| Methyl ether of triethylene acetate | $CH_3O(CH_2CH_2O)_3COCH_3$ | 86.2 |
| Tetra hydro furfuryl laurate | $(C_4H_7O)CH_2OCO(CH_2)_{10}CH_3$ | 93.5 |
| Furfuryl acetate | $(C_4H_3O)CH_2OCOCH_3$ | 57.5 |
| Ethyl furoate | $(C_4H_3O)COOC_2H_5$ | 68.4 |
| Trimethylene glycol dimethoxy acetate | $[CH_3OCH_2COOCH_2]_2CH_2$ | 66.6 |
| Tetra hydro furfuryl methoxy acetate | $(C_4H_7O)CH_2OCOCH_2OCH_3$ | 83.9 |
| Tetra hydro furfuryl benzoate | $(C_4H_7O)CH_2OCOC_6H_5$ | 55.0 |
| Methyl cellosolve carbonate | $[CH_3OCH_2CH_2O]_2CO$ | 67.8 |
| l Menthone | $C_{10}H_{18}O$ | 79.5 |

| | | |
|---|---|---|
| Furfural | $(C_4H_3O)CHO$ | 62.1 |
| Ethyl levulinate | $CH_3COCH_2CH_2COOC_2H_5$ | 89.9 |
| Ethylene glycol | $HOCH_2CH_2OH$ | 10.0 |
| Trimethylene glycol | $HOCH_2CH_2CH_2OH$ | 10.6 |
| Diethylene glycol | $HOCH_2CH_2OCH_2CH_2OH$ | 28.5 |
| Triethylene glycol | $HOCH_2CH_2OCH_2CH_2OCH_2CH_2OH$ | 35.8 |
| Tetra hydro furfuryl alcohol | $(C_4H_7O)CH_2OH$ | 58.8 |
| Benzyl cellosolve | $C_6H_5CH_2O(CH_2)_2OH$ | 39.2 |
| Cellosolve glycolate | $C_2H_5OCH_2CH_2OCOCH_2OH$ | 50.9 |
| Aniline | $C_6H_5NH_2$ | 38.5 |
| Dimethyl aniline | $C_6H_5N(CH_3)_2$ | 69.5 |
| p Amino dimethyl aniline | p $(CH_3)_2NC_6H_4NH_2$ | 47.3 |
| Quinoline | $C_9H_7N$ | 63.3 |
| Tetraethyl oxamide | $(C_2H_5)_2NCOCON(C_2H_5)_2$ | 96.5 |
| N - Diethylamide of mono ethyl malonate | $(C_2H_5)_2NCOCH_2COOC_2H_5$ | 95.0 |
| Acetylpiperidine | $C_5H_{10}NCOCH_3$ | 1.315 |
| Nitrobenzene | $C_6H_5NO_2$ | 47.1 |
| Tetralin | $C_{10}H_{12}$ | 47.5 |
| Decalin | $C_{10}H_{18}$ | 27.2 |
| Benzo trifluoride | $C_6H_5CF_3$ | 33.6 |
| ∝ Mono fluoro naphthalene | $C_{10}H_7F$ | 32.7 |

(1) At a pressure of $CHCl_2F$ corresponding to its vapor pressure at 4.5°.

**MONOCHLORO DIFLURO METHANE $CHClF_2$**

SOLUBILITY OF MONOCHLORO DIFLUORO METHANE IN ORGANIC SOLVENTS AT 32.2°.
(Zellhoefer, Copley and Marvel, 1938.)

| Solvent | Formula | Gms. $CHClF_2$ per 100 gms. solvent (1) |
|---|---|---|
| Ethyl ether of diethylene glycol acetate | $C_2H_5O(CH_2CH_2O)_2COCH_3$ | 114.3 |
| Dimethyl ether of tetra ethylene glycol | $CH_3O(CH_2CH_2O)_4CH_3$ | 109.0 |
| Diethyl ether of diethylene glycol | $C_2H_5(CH_2CH_2O)_2C_2H_5$ | 112.7 |

(1) At a pressure of $CHClF_2$ corresponding to its vapor pressure at 4.5°.

**IODOFORM $CHI_3$.**

SOLUBILITY OF IODOFORM IN SEVERAL SOLVENTS.

| Solvent | t° | Gms. $CHI_3$ per 100 gms. solvent | Authority |
|---|---|---|---|
| Water | 25 | 0.0106 | U.S.P. VIII |
| Ethyl Alcohol | 25 | 2.14 | " " |
| " " | 25 | 1.43 | Vulpius, 1893 |
| " " | b. pt. | 19.2 | U.S.P. VIII |
| " " | " | 10.0 | Vulpius, 1893 |
| Ethyl Ether | 25 | 19.2 | U.S.P. VIII |
| " " | 25 | 16.6 | Vulpius, 1893 |
| Pyridine | 20-25 | 173.1 | Dehn, 1917 |
| Aq. 50% Pyridine | " | 22.4 | " " |
| Lanolin | 46 | 5.2 | Klose, 1907 |

### Solubility of Iodoform in Glycerol.
(Chiaria, 1917, 1919.)

Definite weights of 95 % glycerol ($d_{15} = 1.255$) and $CHI_3$ were heated 2 hours under a reflux condenser and the solution rapidly filtered and cooled to 15°. A definite weight of it was analyzed by adding standard silver nitrate and titrating the excess with sulfocyanate. The solubility was found to be 0.123 gms. $CHI_3$ per 100 gms. sat. sol. at 15°.

Increase in temperature or use of more concentrated glycerol did not greatly increase this result. (Chiaria, 1917, 1919.)

Freezing-point data for mixtures of iodoform and naphthalene gave a single eutectic at 70°.8 and 43.53 wt. per cent $CHI_3$. (Vasilév, 1916.)

## HYDROCYANIC ACID CHN. (See also Vol. I, p. 569.)

Freezing-point data are given for:

HCN + HCOOH (formic Acid) (Peiker and Coffin, 1933.)
" + $C_6H_5CHO$ (benzaldehyde) " " " "

## METHYLENE BROMIDE Di bromo Methane) $CH_2Br_2$.

1000 gms. $H_2O$ dissolve 11.70 gms. $CH_2Br_2$ at 15° and 11.93 gms. at 30°. (Gross and Saylor, 1931.)

Freezing-point data are given for:

| | |
|---|---|
| $CH_2Br_2$ + $CH_2Cl_2$ | (Timmermans, 1934.) |
| " + $CH_2I_2$ | " " |
| " + $C_6H_5NH_2$ | (Timmermans, 1930.) |

### Solubility of Methylene Bromide, Methylene Chloride and Methyl Iodide, Each Separately in Water.
(Rex, 1906.)

| t°. | Gms. per 100 Gms. $H_2O$. | | |
|---|---|---|---|
| | $CH_3I$. | $CH_2Cl_2$. | $CH_2Br_2$. |
| 0 | 1.565 | 2.363 | 1.173 |
| 10 | 1.446 | 2.122 | 1.146 |
| 20 | 1.419 | 2 | 1.148 |
| 30 | 1.429 | 1.969 | 1.176 |

**METHYLENE CHLORIDE** (Dichloro Methane) $CH_2Cl_2$.

SOLUBILITY OF METHYLENE CHLORIDE IN ORGANIC SOLVENTS AT 32.2°.
(Copley, Zellhoeffer and Marvel, 1938a.)

| Solvent | Formula | Gms. $CH_2Cl_2$ per 100 gms. solvent(1) | Mol. Fraction |
|---|---|---|---|
| Phenol | $C_6H_5OH$ | 21.0 | 0.130 |
| Anisole | $C_6H_5OCH_3$ | 38.5 | 0.328 |
| 1,4-Dimethoxy cyclo hexane | $C_6H_{10}(OCH_3)_2$ | 46.0 | 0.442 |
| Diethyl ether of diethylene glycol | $C_2H_5O(CH_2CH_2O)_2C_2H_5$ | 56.8 | 0.520 |
| Dimethyl ether of tetra ethylene glycol | $CH_3O(CH_2CH_2O)_2CH_3$ | 58.0 | 0.602 |
| Acetic acid | $CH_3COOH$ | 28.0 | 0.174 |
| Propionic acid | $C_2H_5COOH$ | 32.0 | 0.218 |
| Triethyl phosphate | $(C_2H_5)_3PO_4$ | 55.0 | 0.541 |
| Tri-n-propyl phosphate | $(C_3H_7)_3PO_4$ | 50.0 | 0.567 |
| Tri-n butyl phosphate | $(C_4H_9)_3PO_4$ | 43.5 | 0.574 |
| Triphenyl phosphite | $(C_6H_5)_3PO_3$ | 19.2 | 0.412 |
| Tri-o-cresol phosphate | $(C_6H_4OCH_3)_3PO_4$ | 21.3 | 0.470 |
| Ethyl ether of diethylene glycol acetate | $C_2H_5O(CH_2CH_2O)COCH_3$ | 50.0 | 0.509 |
| Ethyl aceto acetate | $CH_3COCH_2COOC_2H_5$ | 45.4 | 0.410 |
| Ethyl diethyl aceto acetate | $CH_3COC(C_2H_5)_2COOC_2H_5$ | 40.3 | 0.468 |
| Cyclo hexylamine | $C_6H_{11}NH_2$ | 52.0 | 0.377 |
| Diphenyl amine | $(C_6H_5)_2NH$ | trace | |
| Formamide | $HCONH_2$ | 6.2 | 0.038 |
| Methyl formamide | $HCONHCH_3$ | 36.5 | 0.202 |
| Dimethyl formamide | $HCON(CH_3)_2$ | 41.0 | 0.261 |
| N-Methyl acetamide | $CH_3CONHCH_3$ | 42.7 | 0.269 |
| N,N-Dimethyl acetamide | $CH_2CON(CH_3)_2$ | 80.8 | 0.452 |
| N, Methyl-N-cyclohexyl-n-butane sulfonamide | $C_4H_9SO_2N(CH_3)\ C_6H_{11}$ | 35.1 | 0.490 |
| N, Methyl-N-cyclohexyl acetamide | $C_6H_{11}N(COCH_3)CH_3$ | 60.0 | 0.521 |
| N, Ethyl-N-cyclohexyl acetamide | $C_6H_{11}N(COCH_3)C_2H_5$ | 56.5 | 0.530 |
| Ethyl Methyl ketoxime | $C_2H_5(CH_3)C{=}NOH$ | 31.5 | 0.244 |
| Benzaldehyde | $C_6H_5CHO$ | 43.0 | 0.349 |
| Salicylaldehyde | o $C_6H_4(OH)CHO$ | 32.0 | 0.315 |
| Heptaldehyde | $CH_3(CH_2)_5CHO$ | 47.3 | 0.388 |
| Paraldehyde | $C_6H_{12}O_3$ | 38.5 | 0.374 |
| Cyclohexanone | $C_6H_{10}O$ | 63.0 | 0.421 |
| $\Delta^2$- Cyclohexanone | $C_6H_8O$ | 47.3 | 0.349 |
| Acetyl acetone | $CH_3COCH_2COCH_3$ | 45.5 | 0.394 |
| Acetonyl acetone | $CH_3COCH_2CH_2COCH_3$ | 57.2 | 0.434 |

(1) At a partial pressure of methylene chloride corresponding to its vapor pressure (0.230 atm.) at 4.5°.

The vapor pressure of this compound is 0.739 atmosphere at 32.2°.

The theoretical "Ideal" mol. fraction is 0.311 in the saturated solution. This was calculated by using Raoult's law and is the ratio of the vapor pressure of methylene chloride at 4.5° to its value at 32.2°.

SOLUBILITY OF METHYLENE CHLORIDE IN ORGANIC SOLVENTS AT 30°.
(Zellhoeffer, 1937; Zellhoeffer, Copley and Marvel, 1938.)

| Solvent | Formula | Gms. $CH_2Cl_2$ per 100cc solvent at 181 mm pressure(1) |
|---|---|---|
| Cellosolve acetate | $C_2H_5O(CH_2)_2OCOCH_3$ | 49.3 |
| Carbitol acetate | $C_2H_5O(CH_2CH_2O)_2COCH_3$ | 45.0 |
| Diethyl ether of tetra ethylene glycol | $C_2H_5O(CH_2CH_2O)_4C_2H_5$ | 36.0 |
| Ethyl ether of diethylene glycol acetate | $C_2H_5O(CH_2CH_2O)_2COCH_3$ | 50.0 (2) |
| Dimethyl ether of tetra ethylene glycol | $CH_3O(CH_2CH_2O)_4CH_3$ | 57.5 (2) |
| Diethyl ether of diethylene glycol | $C_2H_5O(CH_2CH_2O)_2C_2H_5$ | 56.7 (2) |

(1) Vapor pressure of $CH_2Cl_2$ at 4.5°.
(2) Gms. per 100 gms. solvent at 181 mm pressure and 32.2°.

Freezing-point data are given for:

| | |
|---|---|
| $CH_2Cl_2$ + $C_2H_5Br$ (Ethyl bromide) | (Timmermans, 1934.) |
| " + $(CH_3)_2CHCH_2Br$ (Iso butyl bromide) | " " |
| " + $CH_3CHCl_2$ (1.1. dichloro ethane) | " " |
| " + $CH_2Cl_2$ (methylene bromide) | " " |
| " + $CH_2I_2$ (methylene iodide) | " " |
| " + $C_6H_5NO_2$ (nitro benzene) | (Hyrnakowski and Szmyt, 1938.) |

**MONOCHLORO MONOFLUORO METHANE** $CH_2ClF$.

SOLUBILITY OF MONOCHLORO, MONOFLUORO METHANE IN ORGANIC SOLVENTS AT 32.2°.
(Zellhoeffer, Copley and Marvel, 1938.)

| Solvent | Formula | Gms. $CH_2ClF$ per 100 gms. solvent(1) |
|---|---|---|
| Ethyl ether of diethylene glycol acetate | $C_2H_5O(CH_2CH_2O)_2COCH_3$ | 53.8 |
| Dimethyl ether of tetra ethylene glycol | $CH_3O(CH_2CH_2O)_4CH_3$ | 57.0 |
| Diethyl ether of diethylene glycol | $C_2H_5O(CH_2CH_2O)_2C_2H_5$ | 58.0 |

At a pressure of $CH_2ClF$ corresponding to its vapor pressure at 4.5°.

**METHYLENE IODIDE** (Diiodo methane) $CH_2I_2$.

1000 gms. $H_2O$ dissolve 1.24 gm. $CH_2I_2$ at 30°. (Gross and Saylor, 1931.)
Freezing-point data are given by Timmermans, 1934, for $CH_2I_2$ + $CHCl_2$ over $CH_2I_2$ + $CH_2Br_2$.

**CYANAMIDE** $CH_2N_2$. (See also Vol. I, p. 216.)

Freezing-point data are given by Pratolongo, 1913, for $CH_2N_2$ + dicyanamid and $CH_2N_2$ + Urea.

$C_1H_2O_1$

**FORMALDEHYDE,** Solid Polymers $(CH_2O)_n$.

SOLUBILITY OF THE SIX WELL-DEFINED SOLID POLYMERS OF FORMALDEHYDE IN WATER. (Auerbach and Barschall, 1908.)

| Name. | Formula. | m. pt. | Gms. per 100 cc. Sat. Solution in Water. |
|---|---|---|---|
| Paraformaldehyde | $(CH_2O)_n+xH_2O$ | 150–160 | 20–30 gms. at 18° |
| α Polyoxymethylene | $(CH_2O)_n$ | 163–8 | 11 gms. at 18–25° |
| β Polyoxymethylene | $(CH_2O)_n$ | 163–8 | 3.3 gms. at 18°, about 4 at 25° |
| γ Polyoxymethylene | $(CH_2O)_n$ | 163–5 | less than 0.1 at 18°, 0.1 gm. at 25° |
| δ Polyoxymethylene | $(CH_2O)_n$ | 169–70 | practically insoluble |
| α Trioxymethylene | $C_3H_6O_3$ | 63–4 | 17.2 at 18°, 21.1 at 25° |

All are insoluble in alcohol and ether except trioxymethylene.

SOLUBILITY OF TRIOXYMETHYLENE IN AQ. SODIUM SULFITE SOLUTIONS AT 15°. (Lumière and Seyewetz, 1902.)

| Gms. $Na_2SO_3$ per 100 cc. $H_2O$ | 5 | 10 | 20 | 25 | 28 (sat.) |
|---|---|---|---|---|---|
| Gms. $C_3H_6O_3$ per 100 cc. sat. sol. | 22 | 24 | 26 | 27 | 27 |

Data are also given for the solubility of various mixtures of trioxymethylene and sodium sulfite in water at 15°.

The distribution coefficient of formaldehyde between water and ether is 8.5 at 0° and 9.23 at 20°. (Hantzsch and Vagt, 1901.)

**FORMIC ACID** HCOOH.

SOLUBILITY IN WATER, DETERMINED BY FREEZING-POINT METHOD. (Faucon, 1910.)

| t° of Solidif. | Gms. HCOOH per 100 Gms. Mixture. | t° of Solidif. | Gms. HCOOH per 100 Gms. Mixture. | t° of Solidif. | Gms. HCOOH per 100 Gms. Mixture. |
|---|---|---|---|---|---|
| 0 | 0 | −30 | 53 | −40 | 74.2 |
| −5 | 12.5 | −35 | 57.6 | −30 | 79 |
| −10 | 23 | −40 | 62.5 | −20 | 84.2 |
| −15 | 32 | −45 | 66.5 | −10 | 89.4 |
| −20 | 39.2 | −49 Eutec. | 70 | 0 | 95 |
| −25 | 46.5 | −45 | 71.7 | +8.51 | 100 |

Similar data for mixtures of 97.4% formic acid and water are given by Kremann, 1907.

SOLUBILITY OF FORMIC ACID IN VARIOUS SOLVENTS AT 25° AND VICE VERSA. (Gordon and Reid, 1922.)

The mixtures were constantly shaken at 25° for 4 hours. After separation of the two layers, the formic acid in a weighed amount of each was determined by titration. The weight of the other constituent was calculated by difference.

Solubility of Formic Acid in Various Solvents.

| Solvent. | Gms. HCOOH per 100 gms. solvent. |
|---|---|
| Benzene | 14.40 |
| Bromoform | 2.45 |
| Carbon disulfide | 1.28 |
| Carbon tetra chloride | 3.43 |
| Cotton seed oil | 8.68 |
| Kerosene | 0.897 |
| Toluene | 11.04 |
| Xylene | 8.74 |

Solubility of Various Compounds in Anhydrous Formic Acid.

| Compound. | Gms. compound per 100 gms. HCOOH |
|---|---|
| Benzene | 15.14 |
| Bromoform | 25.3 |
| Carbon disulfide | 4.66 |
| Carbon tetra chloride | 6.95 |
| Cotton seed oil | 0.77 |
| Kerosene | 1.56 |
| Toluene | 9.08 |
| Xylene | 7.29 |

## FORMIC ACID HCOOH.

### Equilibrium in the System Formic Acid, Aniline and Water at 15°.
(Pound and Wilson, 1935.)

The system is characterized by a region in which the components separate into two liquid layers and one in which crystals of aniline formate, $C_6H_7NCH_2O_2$, are formed. These liquid mixtures and solid crystals change continuously, producing formanilide and water. The crystals redissolve and the homogeneous liquid mixtures separate in time, into two layers.

The authors determined the binodal curve by titrating aqueous formic acid mixtures with aniline. The end point, shown by opalescence, could be determined to within one drop of aniline. Three tie lines showing the percentage of formic acid in adjoining layers were determined. Using these and the values for the binodal curve the following results for the composition of a series of liquid layers in contact with each other have been estimated.

| Gms. per 100 gms. aqueous layer | | | Gms. per 100 gms. aniline layer | | |
|---|---|---|---|---|---|
| HCOOH | $C_6H_5NH_2$ | $H_2O$ | HCOOH | $C_6H_5NH_2$ | $H_2O$ |
| 0.0 | 3.6 | 96.4 | 0.0 | 95.0 | 5.0 |
| 4.0 | 12.0 | 84.0 | 0.65 | 93.5 | 5.85 |
| 5.5 | 15.5 | 79.0 | 1.7 | 91.0 | 7.3 |
| 7.1 | 21.0 | 71.9 | 3.8 | 83.5 | 12.7 |
| 8.3 | 28.5 | 63.2 | 6.0 | 72.0 | 22.0 |
| 8.5 | 41.0 | 50.5 | 7.4 | 62.0 | 30.6 |
| 8.2 | 50.0 | 41.8 | 8.2 | 50.0 | 41.8 P.P. |

In addition to the binodal curve the authors determined the region in which aniline formate is formed. The saturated solutions were prepared by agitating known mixtures of aniline and formic acid at 15° for ¾ hour or longer and analyzing the solution and the solid phase which separated. Points on the curve were also determined by titrating formic acid solutions with aniline at 15° until crystals remained in the solution and also by titrating aniline with formic acid solutions until crystals persisted. Although the appearance of the crystals varied with the different conditions under which they were formed, analysis showed them to be the formate in all cases. The following points on the curve were determined.

| Gms. per 100 gms. sat. solution | | | Solid Phase |
|---|---|---|---|
| HCOOH | $C_6H_5NH_2$ | $H_2O$ | |
| 7.2 | 79.6 | 13.2 | $C_6H_7N.CH_2O_2$ |
| 11.3 | 64.8 | 23.9 | " |
| 12.5 | 51.9 | 35.6 | " |
| 18.4 | 38.5 | 43.1 | " |
| 24.0 | 36.8 | 39.2 | " |
| 33.1 | 35.1 | 31.8 | " |
| 41.1 | 38.1 | 20.8 | " |

The authors also describe the changes which occur on keeping the liquid mixtures and the crystals of aniline formate.

MUTUAL SOLUBILITY OF BENZENE AND FORMIC ACID. SYNTHETIC METHOD. (Ewins, 1914.)

| t° of Miscibility | Gms. HCOOH per 100 Gms. Sol. | t° of Miscibility. | Gms. HCOOH per 100 Gms. Sol. | t° of Miscibility. | Gms. HCOOH per 100 Gms. Sol. |
|---|---|---|---|---|---|
| 21 | 9.2 | 70 | 31.5 | 60 | 74 |
| 30 | 10.3 | 72 | 35 | 40 | 82 |
| 40 | 12.2 | 73.2 | 43–51 | 20 | 87 |
| 50 | 16.5 | 72 | 60 | 5 | 89.6 |
| 69 | 22 | 70 | 65 | | |

Results for this system are also given by Wrewsky, Held and Scukarev, 1928, 1929. The critical solution temperature is reported by Timmermans and Mme. Hennaut-Roland, 1930, to be 74.15°.

SOLUBILITY OF BENZENE IN AQUEOUS SOLUTIONS OF FORMIC ACID. SYNTHETIC METHOD. (Ewins, 1914.)

| In 95 Wt. % HCOOH. | | In 85 Wt. % HCOOH. | | In 75 Wt. % HCOOH. | | In 60 Wt. % HCOOH. | |
|---|---|---|---|---|---|---|---|
| t° of Miscibility. | Gms. $C_6H_6$ per 100 Gms. Sol. | t° of Miscibility. | Gms. $C_6H_6$ per 100 Gms. Sol. | t° of Miscibility. | Gms. $C_6H_6$ per 100 Gms. Sol. | t° of Miscibility. | Gms. $C_6H_6$ per 100 Gms. Sol. |
| 57.5 | 96.3 | 71 | 97.5 | 122 | 12 | 105 | 6 |
| 77 | 94.4 | 87 | 96.6 | 97.5 | 8.5 | 82 | 3.8 |
| 95 | 89.8 | 101 | 96 | 74 | 6 | 76 | 3 |
| 112 | 85.2 | 100.5 | 14.3 | | | | |
| 94.5 | 24.7 | 81 | 10 | | | | |
| 80.5 | 20 | 46 | 7 | | | | |
| 51 | 12.5 | | | | | | |

DISTRIBUTION OF FORMIC ACID AT 25° BETWEEN : (Gordon and Reid, 1922.)

| Water and Carbon Disulfide. | | Water and Carbon Tetrachloride. | | Water and Cotton Seed Oil. | | | |
|---|---|---|---|---|---|---|---|
| Gms. H COO H per 100 gms. | | Gms. H COO H per 100 gms. | | Gms. H COO H per 100 gms. | | Gms. H COO H per 100 gms. | |
| $H_2O$ layer. | $CS_2$ layer. | $H_2O$ layer. | $CCl_4$ layer. | $H_2O$ layer. | C.S.O. layer. | $H_2O$ layer. | C.S.O. layer. |
| 4.8 | 0.00318 | 5.8 | 0.00378 | 1.1 | 0.0172 | 20.9 | 0.331 |
| 8.4 | 0.00574 | 8.6 | 0.0081 | 2.3 | 0.036 | 30.3 | 0.489 |
| 14.6 | 0.0105 | 17.5 | 0.01135 | 3.7 | 0.057 | 51.1 | 1.10 |
| 25.7 | 0.0215 | 26.9 | 0.0273 | 5.5 | 0.0878 | 62.5 | 1.67 |
| 41.6 | 0.0438 | 43.2 | 0.0631 | 8.1 | 0.1305 | 71.3 | 2.43 |
| 54.8 | 0.0750 | 58.9 | 0.1700 | 12.7 | 0.193 | 80.7 | 3.50 |
| | | | | 14.4 | 0.220 | 87.2 | 4.86 |

The average value for the distribution of formic acid between water and chloroform at 25° was found by Smith, 1921-1922, to be 32.2 millimols H CO OH per liter of the $H_2O$ layer and 1.0 millimol per liter of the $CH Cl_3$ layer.

Results showing the distribution of formic acid between water and olive oil are given by Bodansky, 1928.

DISTRIBUTION OF FORMIC ACID BETWEEN WATER AND ETHER

at 15°. (Pinnow, 1919, 1922.)

| Conc. of H CO OH in | | |
|---|---|---|
| $H_2O$ layer (1). | $(C_2H_5)_2O$ layer (2). | $\frac{(1)}{(2)}$ |
| 1.154 | 0.526 | 2.19 |
| 0.619 | 0.274 | 2.26 |
| 0.322 | 0.134 | 2.40 |
| 0.146 | 0.0584 | 2.50 |
| 0.0976 | 0.0386 | 2.51 |
| 0.0523 | 0.0210 | 2.49 |

at 26°.3. (Pinnow, 1919, 1922.)

| Conc. of H COO H in | | |
|---|---|---|
| $H_2O$ layer (1). | $(C_2H_5)_2O$ layer (2). | $\frac{(1)}{(2)}$ |
| 1.245 | 0.488 | 2.51 |
| 0.663 | 0.245 | 2.71 |
| 0.394 | 0.142 | 2.77 |
| 0.158 | 0.0561 | 2.82 |

at 25°. (Smith, 1921, 1922.)

| Millimols H COO H per liter | | |
|---|---|---|
| $H_2O$ layer ($C_1$). | $(C_2H_5)_2O$ layer ($C_2$). | $\frac{C_1}{C_2}$. |
| 30.00 | 13.25 | 2.26 |
| 13.45 | 4.75 | 2.77 |
| 8.85 | 3.25 | 2.72 |
| 6.55 | 2.30 | 2.85 |
| 4.775 | 1.625 | 2.94 |

### Distribution of Formic Acid Between Water and Ether at 18°.
(Auerbach and Zeglin, 1922.)

| Gm. mols. HCOOH per liter of $H_2O$ layer (1). | Gm. mols. HCOOH per liter of $(C_2H_5)_2O$ layer (2). | (1)/(2) | Gm. mols. HCOOH per liter of $H_2O$ layer (1). | Gm. mols. HCOOH per liter of $(C_2H_5)_2O$ layer (2). | (1)/(2) |
|---|---|---|---|---|---|
| 0.0476 | 0.0176 | 2.53 | 0.3695 | 0.1477 | 2.44 |
| 0.0499 | 0.0185 | 2.52 | 0.5090 | 0.2074 | 2.41 |
| 0.0960 | 0.0364 | 2.52 | 0.6782 | 0.2799 | 2.38 |
| 0.1036 | 0.0394 | 2.52 | 0.8358 | 0.3494 | 2.33 |
| 0.1954 | 0.0756 | 2.50 | 1.058 | 0.4531 | 2.30 |
| 0.2868 | 0.1131 | 2.47 | 1.349 | 0.6068 | 2.20 |

### Distribution of Formic Acid Between Aqueous 0.5 *n* Sulfuric Acid Solutions and Ether at 18°. (Auerbach and Zeglin, 1922.)

| Gm. mols. HCOOH per liter of 0.5 *n* $H_2SO_4$ layer (1). | Gm. mols. HCOOH per liter of $(C_2H_5)_2O$ layer (2). | (1)/(2) | Gm. mols. HCOOH per liter of 0.5 *n* $H_2SO_4$ layer (1). | Gm. mols. HCOOH per liter of $(C_2H_5)_2O$ layer (2). | (1)/(2) |
|---|---|---|---|---|---|
| 0.0501 | 0.0200 | 2.50 | 0.4786 | 0.2003 | 2.39 |
| 0.0928 | 0.0373 | 2.49 | 0.4930 | 0.2070 | 2.38 |
| 0.1710 | 0.0694 | 2.47 | 0.6724 | 0.2888 | 2.33 |
| 0.1964 | 0.0803 | 2.45 | 0.8517 | 0.3732 | 2.28 |
| 0.3164 | 0.1302 | 2.43 | 0.8890 | 0.3913 | 2.27 |
| 0.3455 | 0.1426 | 2.42 | 1.268 | 0.5834 | 2.17 |
| 0.4061 | 0.1687 | 2.41 | 1.320 | 0.6116 | 2.16 |

Data for the distribution of formic acid between ether and aq. 0.5 *n* $H_2SO_4$ containing 200 gms. of glucose per liter, are given by Auerbach and Beck, 1926. The experiments were made for the purpose of perfecting a method for the determination of formic acid in sugar containing foodstuffs such as honey, fruit juices and marmalades.

Data for the extraction of formic acid from water by ether are given by Dakin, Janney and Wakemann, 1913.

### Distribution of Formic Acid Between Water and Benzene at 13–15°.
(v. Georgievics, 1913.)

A small separatory funnel was used and the acid in each layer titrated with 0.1 *n* NaOH, using phenolphthaleine as indicator.

| Gms. HCOOH Found per: 25 cc. $H_2O$ Layer. | 150 cc. $C_6H_6$ Layer. | Gms. HCOOH Found per: 25 cc. $H_2O$ Layer. | 150 cc. $C_6H_6$ Layer. |
|---|---|---|---|
| 1.016 | 0.016 | 2.365 | 0.035 |
| 1.539 | 0.031 | 3.826 | 0.062 |
| 1.800 | 0.024 | 5.874 | 0.114 |
| 2.112 | 0.031 | 7.836 | 0.138 |

The distribution ratio of formic acid between water and benzene was found by King and Narracott (1909) to be 1 to 0.0242 at room temp.

### Distribution of Formic Acid at 25° Between :

#### Water and Benzene.
(Brown and Bury, 1923.)

| Normality of HCOOH In $H_2O$ layer. | In $C_6H_6$ layer. |
|---|---|
| 3.400 | 0.0117 |
| 3.757 | 0.0138 |
| 3.933 | 0.0147 |
| 4.689 | 0.0188 |
| 5.483 | 0.0233 |
| 6.806 | 0.0348 |

#### Water and Benzene.
(Gordon and Reid, 1922.)

| Gms. HCOOH per 100 gms. $H_2O$ layer. | $C_6H_6$ layer. |
|---|---|
| 5.3 | 0.0170 |
| 6.4 | 0.0197 |
| 9.9 | 0.0400 |
| 13.6 | 0.0584 |
| 18.5 | 0.0840 |
| 29.2 | 0.156 |
| 41.2 | 0.322 |
| 58.2 | 0.800 |

#### Water and Bromoform.
(Gordon and Reid, 1922.)

| Gms. HCOOH per 100 gms. $H_2O$ layer. | $CHBr_3$ layer. |
|---|---|
| 3.1 | 0.114 |
| 6.9 | 0.180 |
| 10.8 | 0.176 |
| 23.1 | 0.394 |
| 39.0 | 0.675 |
| 53.6 | 1.195 |

## Distribution of Formic Acid Between Water and Chloroform at:

| 0° (Bektourov, 1939.) | | 19° (Schilow and Lepin, 1922.) | | 50° (Bektourov, 1939.) | |
|---|---|---|---|---|---|
| Gm. Equiv. HCOOH per liter | | Normality HCOOH in: | | Gm. Equiv. HCOOH per liter | |
| $H_2O$ layer | $CHCl_3$ layer | $H_2O$ layer | $CHCl_3$ layer | $H_2O$ layer | $CHCl_3$ layer |
| 1.7495 | 0.00709 | 2.25 | 0.0174 | 1.6431 | 0.01418 |
| 3.2153 | 0.01537 | 4.22 | 0.0348 | 2.2223 | 0.02010 |
| 4.2556 | 0.02246 | 7.67 | 0.0783 | 3.1207 | 0.0295 |
| 7.7546 | 0.0543 | 13.08 | 0.244 | 5.1185 | 0.0556 |
| 9.5041 | 0.0827 | 17.82 | 1.131 | 8.2038 | 0.1182 |
| 11.7973 | 0.1418 | | | 11.1117 | 0.2009 |

## Distribution of Formic Acid Between Water and Carbon Tetrachloride.

(Bektourov, 1939.)

| 0° | | 25° | | 60° | |
|---|---|---|---|---|---|
| Gm. Equiv. HCOOH per liter | | Gm. Equiv. HCOOH per liter | | Gm. Equiv. HCOOH per liter | |
| $H_2O$ layer | $CCl_4$ layer | $H_2O$ layer | $CCl_4$ layer | $H_2O$ layer | $CCl_4$ layer |
| 4.4920 | 0.003546 | 4.1492 | 0.004728 | 3.5936 | 0.00662 |
| 5.4377 | 0.005910 | 6.4306 | 0.00946 | 7.6364 | 0.0236 |
| 8.3929 | 0.01300 | 10.0005 | 0.0212 | 9.5986 | 0.0354 |
| 10.0005 | 0.01888 | 12.9794 | 0.0361 | 11.9865 | 0.0591 |
| 12.2465 | 0.0283 | 14.3270 | 0.04728 | 14.5871 | 0.0886 |
| 17.6133 | 0.0827 | | | | |

## Distribution of Formic Acid at 25° Between:

(Archibald, 1932.)

| Water and: | Gm. Mols. HCOOH per liter | | $\frac{C_2}{C_1}$ |
|---|---|---|---|
| | $H_2O$ layer ($c_1$) | Organic layer ($C_2$) | |
| Amyl alcohol | 0.14386 | 0.08318 | 0.5782 |
| | 0.48989 | 0.25472 | 0.5200 |
| Tertiary amyl alcohol | 0.11443 | 0.13015 | 1.1373 |
| | 0.36056 | 0.39705 | 1.1012 |
| Normal butyl alcohol | 0.25622 | 0.22507 | 0.8486 |
| | 0.78493 | 0.63554 | 0.8097 |
| Secondary Butyl alcohol | 0.11830 | 0.12781 | 1.0804 |
| | 0.34625 | 0.36953 | 1.0672 |
| Methyl ethyl ketone | 0.12269 | 0.16511 | 1.3457 |
| | 0.34252 | 0.44332 | 1.2942 |

## Distribution of Formic Acid Between Water and Benzene.

(Bektourow, 1939.)

| 0° | | 25° | | 60° | |
|---|---|---|---|---|---|
| Gm. Equiv. HCOOH per liter | | Gm. Equiv. HCOOH per liter | | Gm. Equiv. HCOOH per liter | |
| $H_2O$ layer | $C_6H_6$ layer | $H_2O$ layer | $C_6H_6$ layer | $H_2O$ layer | $C_6H_6$ layer |
| 1.4573 | 0.00226 | 2.5739 | 0.00568 | 3.3877 | 0.0208 |
| 2.7443 | 0.00454 | 4.6747 | 0.0123 | 4.5233 | 0.0303 |
| 3.3310 | 0.00645 | 6.2645 | 0.0208 | 6.1699 | 0.0473 |
| 7.9868 | 0.0240 | 7.4000 | 0.0265 | 7.7691 | 0.0693 |
| 10.0308 | 0.0378 | 8.2423 | 0.0325 | 9.2737 | 0.0947 |
| 12.6615 | 0.0599 | 9.0466 | 0.0378 | 10.9771 | 0.1419 |
| | | | | 12.1126 | 0.1514 |

## Distribution of Formic Acid Between Water and Nitrobenzene at 25°.

(de Kolossowsky, Kulikow and Bekturow, 1935.)

| Gm. Mol. HCOOH per liter | | $\frac{C_1}{C_2}$ | Gm. Mol. HCOOH per liter | | $\frac{C_1}{C_2}$ |
|---|---|---|---|---|---|
| $H_2O$ layer($C_1$) | $C_6H_5NO_2$ layer($C_2$) | | $H_2O$ layer($C_1$) | $C_6H_5NO_2$ layer($C_2$) | |
| 0.185 | 0.0038 | 48.7 | 9.6828 | 0.3164 | 30.6 |
| 0.489 | 0.01025 | 47.7 | 12.2466 | 0.4942 | 24.8 |
| 0.9215 | 0.0193 | 47.7 | 14.2632 | 0.7749 | 18.4 |
| 1.230 | 0.026 | 47.3 | 16.5942 | 2.1798 | 7.6 |
| 1.878 | 0.041 | 45.8 | 16.5060 | 3.1827 | 5.2 |
| 3.1248 | 0.0693 | 45.1 | 16.3206 | 3.4776 | 4.7 |
| 4.6384 | 0.1108 | 41.9 | 14.918 | 4.985 | 2.99 |
| 5.991 | 0.1539 | 38.9 | 13.608 | 6.3512 | 2.14 |

## Distribution of Formic Acid Between Water and Toluene at 25°.

(de Kolossowsky and Megenine, 1932.)

| Gm. Equiv. HCOOH per liter | | $\frac{C_1}{C_2}$ | Gm. Equiv. HCOOH per liter | | $\frac{C_1}{C_2}$ |
|---|---|---|---|---|---|
| $H_2O$ layer($C_1$) | $C_6H_5CH_3$ layer($C_2$) | | $H_2O$ layer($C_1$) | $C_6H_5CH_3$ layer($C_2$) | |
| 0.9978 | 0.002203 | 452.9 | 14.85 | 0.1503 | 115.0 |
| 2.9922 | 0.007760 | 385.6 | 16.76 | 0.2374 | 70.6 |
| 4.9846 | 0.015394 | 323.8 | 18.61 | 0.3878 | 48.0 |
| 6.9739 | 0.02606 | 267.6 | 20.34 | 0.6563 | 31.0 |
| 8.9587 | 0.04128 | 217.0 | 21.88 | 1.1165 | 19.6 |
| 10.936 | 0.06366 | 171.8 | 23.31 | 1.689 | 13.8 |
| 12.903 | 0.0937 | 132.6 | 24.16 | 1.844 | 13.1 |

## Distribution of Formic Acid at 25° Between :

(Gorden and Reid 1922.)

### Water and Kerosene.

| Gms. HCOOH per 100 gms. | |
|---|---|
| $H_2O$ layer | Kerosene layer. |
| 17.9 | 0.0099 |
| 30.9 | 0.0218 |
| 38.9 | 0.0329 |
| 43.2 | 0.0415 |
| 59.8 | 0.126 |
| 66.3 | 0.173 |

### Water and Toluene.

| Gms. HCOOH per 100 gms. | |
|---|---|
| $H_2O$ layer | Toluene layer. |
| 5.3 | 0.0149 |
| 7.9 | 0.0246 |
| 16.5 | 0.0566 |
| 31.0 | 0.1375 |
| 41.7 | 0.270 |
| 59.7 | 0.726 |

### Water and Xylene

| Gms. HCOOH per 100 gms. | | Gms. HCOOH per 100 gms. | |
|---|---|---|---|
| $H_2O$ layer. | Xylene layer. | $H_2O$ layer. | Xylene layer. |
| 5.0 | 0.0208 | 25.6 | 0.1155 |
| 5.1 | 0.0238 | 26.4 | 0.1120 |
| 8.6 | 0.0421 | 40.4 | 0.223 |
| 9.6 | 0.0420 | 41.2 | 0.254 |
| 15.0 | 0.0572 | 55.2 | 0.500 |
| 15.6 | 0.0556 | 55.7 | 0.493 |
| | | 60.3 | 0.661 |

## Distribution of Formic Acid Between Water and Ortho Nitro Toluene at 25°.

(de Kolossowsky, 1934; de Kolossowsky, Kulikow and Bekturow, 1935.)

| Gm. Mols. HCOOH per liter | | $\frac{C_1}{C_2}$ | Gm. Mols. HCOOH per liter | | $\frac{C_1}{C_2}$ |
|---|---|---|---|---|---|
| $H_2O$ layer($C_1$) | o $C_6H_4CH_3.NO_2$($C_2$) | | $H_2O$ layer($C_1$) | o $C_6H_4CH_3.NO_2$($C_2$) | |
| 0.3073 | 0.0047 | 65.4 | 4.708 | 0.0846 | 55.65 |
| 0.6005 | 0.0095 | 63.2 | 6.619 | 0.131 | 50.2 |
| 0.8747 | 0.0143 | 61.2 | 13.818 | 0.520 | 26.6 |
| 1.4538 | 0.0234 | 62.1 | 15.602 | 0.786 | 19.85 |
| 2.1962 | 0.0369 | 59.5 | 18.498 | 2.092 | 8.84 |
| 3.3592 | 0.0563 | 59.7 | 17.765 | 3.966 | 4.48 |

## Distribution of Formic Acid Between:

### Water and Petroleum Ether

(Grossfeld and Mermelster, 1932.)

| cc. 0.1n NaOH required per 25 cc. | | $\frac{C_1}{C_2}$ |
|---|---|---|
| $H_2O$ layer($C_1$) | Pet. Ether layer($C_2$) | |
| 21.6 | 0.024 | 900 |
| 48.9 | 0.028 | 1750 |
| 138.0 | 0.044 | 3140 |
| 169.0 | 0.055 | 3070 |
| 224.9 | 0.078 | 2880 |

### Methyl Alcohol and i-Octane(1) at 0°.

(Smith and Norton, 1932.)

| Gm. Mol. HCOOH per liter | | $\frac{C_2}{C_1}$ |
|---|---|---|
| $CH_3OH$ layer($C_1$) | i.Oct. layer($C_2$) | |
| 0.1633 | 0.00505 | 0.0309 |
| 0.5084 | 0.01271 | 0.0250 |

(1) = 2.2.4 - Tri methyl Pentane

## Distribution of Formic Acid at 25° Between Acetone and Glycerol.

(Smith, 1921-1922.)

| Millimols. HCOOH per liter of | | $\frac{A}{G}$. |
|---|---|---|
| Acetone layer (A). | Glycerol layer (G). | |
| 2.075 | 1.525 | 1.36 |
| 2.8875 | 2.0625 | 1.40 |
| 5.65 | 3.70 | 1.39 |
| 7.8 | 5.65 | 1.38 |
| 20.8 | 16.0 | 1.30 |

## Distribution of Formic Acid Between 2.2.4 Trimethyl Pentane and β Methoxy Ethanol.

(Henriques, 1933.)

Results at -19.5 °

| Millimols HCOOH per liter | | $\frac{C_1}{C_2}$ |
|---|---|---|
| Pentane layer($C_1$) | Ethanol layer($C_2$) | |
| 1.3 | 252.9 | 0.0051 |
| 3.3 | 203.6 | 0.0046 |

Results at 0°

| Millimols HCOOH per liter | | $\frac{C_1}{C_2}$ |
|---|---|---|
| Pentane layer($C_1$) | Ethanol layer($C_2$) | |
| 1.1 | 248.3 | 0.0046 |
| 3.4 | 667.9 | 0.0051 |
| 4.6 | 720.7 | 0.0064 |
| 4.9 | 961.7 | 0.0051 |

### Reciprocal Solubility of Formic Acid and Allyl Iso Sulfocyanide ($CH_2$:$CHCH_2NCS$)

(Jankovsky, 1934.)

| t° | Gms. HCOOH per 100 gms. mixture | t° | Gms. HCOOH per 100 gms. mixture | t° | Gms. HCOOH per 100 gms. mixture |
|---|---|---|---|---|---|
| 6.5 | 6.6 | 39.7 | 38.8 | 35.8 | 67.7 |
| 25 | 11.5 | 39.8* | 45.0 | 33.5 | 70.1 |
| 36 | 25.8 | 39.1 | 51.2 | 26 | 77.5 |
| 39 | 33.8 | 38.2 | 55.4 | 10 | 84.0 |

* Critical Solution Temperature.

The author also studied the reciprocal solubility of Formic Acid and Tri Ethyl Amine but found that the addition compound which is formed separates into two liquid layers at the moment of fusion. The limits of reciprocal solubility in this system at the ordinary temperature are 1.4 and 39.2 gms. HCOOH per 100 gms. of the mixture.

The limit of reciprocal solubility of Formic Acid and Ethylene Bromide is at 51.5 percent HCOOH and 71.8°. (Lecat, 1930.)

The limit of reciprocal solubility of Formic Acid and n Pentane is at 10.0 percent HCOOH and 28°. (Lecat, 1930.)

Freezing-point data are given for:

| | |
|---|---|
| HCOOH + HCN | (Peiker and Coffin, 1933.) |
| " + HCOOK | (Kendall and Adler, 1921.) |
| " + HCOOLi | " " " |
| " + $HCOONH_4$ | " " " |
| " + HCOONa | " " " |
| " + $(HCOO)_2Pb$ | " " " |
| " + $(HCOO)_2Ca$ | " " " |
| " + $CH_3COOH$ | (Baud, 1913c) |
| " + $HCOONH_2$ (formamide) | (Joukovsky, 1934.) |
| " + $CH_3CN$ (acetonitrile) | " " |
| " + $CH_3NO_2$ (nitro methane) | " " |
| " + $N(C_2H_5)_3$ (tri ethyl amine) | " " |
| " + $C_4H_5NS$ (allyl iso sulfocyanide) | " " |
| " + o $C_6H_4ClNO_2$ (o chloro nitro benzene) | (Bruni and Berti, 1900.) |
| " + $C_7H_8O_2$ (di methyl pyrone) | (Kendall, 1914.) |

## METHYL CHLORIDE $CH_3Cl$.

### Solubility of Methyl Chloride in Several Organic Solvents. (Kling, 1915.)

The results are expressed in terms of $l_t = (V - V_0)\frac{T_t}{F_t} - (V_n - V_c) \div V_c$ in which V = volume of gas after absorption, $V_0$ = original volume of gas, $T_t$ = temp. on absolute scale, $F_t$ = temp. of thermostat, $V_n$ = volume of the flask, $V_c$ = volume of solvent.

$l_t$ in each solvent determined separately.

| t°. | $CHCl_3$. | $CHCl$ \| $CHCl$ | $CCl_3$ \| $CHCl_2$ | $CCl_4$. |
|---|---|---|---|---|
| — 5 | 276.8 | 239.4 | 168.1 | 115.4 |
| 0 | 202.5 | 174.8 | 125.2 | 87.6 |
| + 5 | 158.3 | 130.7 | 98.7 | 68.7 |
| 10 | 119.5 | 101.2 | 79.0 | 56.2 |
| 15 | 93.5 | 76.9 | 65.1 | 45.9 |
| 20 | 72.9 | 58.6 | 54.1 | 38.0 |

## Solubility of Methyl Chloride in Carbon Tetrachloride and in Dichlor Ethane at Several Temperatures and Partial Pressures.

(Kaplan and Romantchouk, 1936.)

| Partial Pressure of $CH_3Cl$ in mm Hg. | cc $CH_3Cl$ (at 0° and 760mm) dissolved per 1cc $CCl_4$ at: | | | cc $CH_3Cl$ (at 0° and 760mm) dissolved per 1cc $C_2H_2Cl_2$ at: | | |
|---|---|---|---|---|---|---|
| | -10° | 0° | +20° | -10° | 0° | +20° |
| 760 | 145 | 83 | 38 | 336 | 152 | 76 |
| 700 | 124 | 71 | 36 | 294 | 134 | 67 |
| 600 | 95 | 56 | 30 | 228 | 106 | 54 |
| 500 | 71 | 42 | 24 | 170 | 82 | 42 |
| 400 | 52 | 30 | 19 | 130 | 60 | 33 |
| 300 | 36 | 19 | 14 | 92 | 42 | 24 |
| 200 | 22 | 12 | 10 | 58 | 25 | 16 |
| 100 | 10 | 6 | 5 | 28 | 10 | 8 |

## Solubility of Methyl Chloride in Several Solvents at Varying Pressures.

(Horiuti, 1931.)

Results for:

Acetone $(CH_3)_2CO$

| P(mm) | Gm. Mol. $CH_3Cl$ per 1.0 gm. mol. sat. sol. |
|---|---|
| 229.2 | 0.0000 |
| 292.1 | 0.0182 |
| 412.7 | 0.0522 |
| 540.6 | 0.0891 |
| 674.2 | 0.1255 |
| 808.8 | 0.1637 |
| 1014.3 | 0.2195 |

Methyl Acetate, $CH_3COOCH_3$

| P(mm) | Gm. Mol. $CH_3Cl$ per 1.0 gm. mol. sat. sol. |
|---|---|
| 213.4 | 0.0000 |
| 294.9 | 0.0227 |
| 410.8 | 0.0560 |
| 526.9 | 0.0886 |
| 631.0 | 0.1176 |
| 773.9 | 0.1575 |
| 979.0 | 0.2119 |

Chloroform, $CHCl_3$

| P(mm) | Gm. Mol. $CH_3Cl$ per 1.0 gm. mol. sat. sol. |
|---|---|
| 197.1 | 0.0000 |
| 270.7 | 0.0230 |
| 404.9 | 0.0627 |
| 558.2 | 0.1074 |
| 702.3 | 0.1483 |
| 855.2 | 0.1912 |
| 973.0 | 0.2232 |

Carbon Tetrachloride $CCl_4$

| P(mm) | Gm. Mol. $CH_3Cl$ per 1.0 gm. mol. sat. sol. |
|---|---|
| 112.4 | 0.0000 |
| 256.9 | 0.0280 |
| 431.4 | 0.0639 |
| 603.7 | 0.0996 |
| 758.1 | 0.1328 |
| 890.5 | 0.1623 |
| 1023.9 | 0.1926 |

Benzene, $C_6H_6$

| P(mm) | Gm. Mol. $CH_3Cl$ per 1.0 gm. mol. sat. sol. |
|---|---|
| 93.7 | 0.0000 |
| 190.2 | 0.0248 |
| 329.0 | 0.0608 |
| 463.8 | 0.0955 |
| 626.6 | 0.1373 |
| 776.6 | 0.1758 |
| 1012.7 | 0.02349 |

Chloro benzene, $C_6H_5Cl$

| P(mm) | Gm. Mol. $CH_3Cl$ per 1.0 gm. mol. sat. sol. |
|---|---|
| 11.6 | 0.0000 |
| 151.7 | 0.0337 |
| 311.7 | 0.0719 |
| 503.5 | 0.1180 |
| 669.9 | 0.1572 |
| 908.6 | 0.2121 |
| 1060.9 | 0.2479 |

The solubilities of $CH_3Cl$ in the above solvents at one atmosphere pressure, in terms of the Ostwald Solubility Expression $l$ (see p. 37 as calculated by Horiuti are as follows

| Solvent | $l$ | Solvent | $l$ |
|---|---|---|---|
| Acetone | 69.3 | Carbon Tetrachloride | 40.9 |
| Methyl Acetate | 64.3 | Benzene | 55.9 |
| Chloroform | 67.6 | Chloro benzene | 47.2 |

The solubility of Methyl Chloride in Cyclohexanol ($C_6H_{11}OH$), in terms of the Ostwald Solubility Expression (the ratio of the volume (v) of gas absorbed to the vol. (V) of the absorbing liquid), is 17.7 at 26°.

(Cauquil, 1927.)

Results for the solubility of Methyl Chloride in Fenchon ($C_{10}H_{16}O$) are given by Pasteur, 1931.

## METHYL CHLORIDE $CH_3Cl$.

### SOLUBILITY OF METHYL CHLORIDE IN ORGANIC SOLVENTS AT 32°.

(Zellhoeffer, 1937; Zellhoeffer, Copley and Marvel, 1938.)

| Solvent | Formula | Gm. $CH_3Cl$ per 100cc solvent at 2203 mm pressure (1) |
|---|---|---|
| Cellosolve acetate | $C_2H_5O(CH_2)_2OCOCH_3$ | 36.4 |
| Carbitol acetate | $C_2H_5O(CH_2CH_2O)_2COCH_3$ | 32.2 |
| " ethyl ether | $C_2H_5O(CH_2CH_2O)_2C_2H_5$ | 32.4 |
| Dimethyl ether of tetraethylene glycol | $CH_3O(CH_2CH_2O)_4CH_3$ | 32.5(2) |
| Diethyl ether of tetraethylene glycol | $C_2H_5O(CH_2CH_2O)_4C_2H_5$ | 30.2 |
| Dimethyl ether of triethylene glycol | $[CH_3O(CH_2)_2OCH_2]_2$ | 34.4 |
| Carbitol methoxy acetate | $(C_2H_5O(CH_2CH_2O)_2COCH_2OCH_3$ | —— |
| Butyl carbitol acetate | $n$-$C_4H_9O(CH_2CH_2O)_2COCH_3$ | 29.4 |
| Diethylene glycol diacetate | $[CH_3COOCH_2CH_2]_2O$ | 24.8 |
| 4-Methyl-2-pentanol acetate | $(CH_3)_2CHCH_2CH(OCOCH_3)CH_3$ | 30.4 |
| y,y'-Dichloro-n-propyl ether | $(ClCH_2CH_2CH_2)_2O$ | 28.2 |
| Dichloro iso propyl ether | $(C_3H_6Cl)_2O$ | 29.4 |
| α Fluoro naphthalene | $C_{10}H_7F$ | 26.2 |
| Tri chloro benzene | $C_6H_3Cl_3$ | 19.4 |
| 1.1.2.2-Tetra chloro ethane | $Cl_2CHCHCl_2$ | 35.0 |
| Butyl cellosolve n butyrate | $n$ $C_4H_9O(CH_2)_2OCO$-$n$$C_3H_7$ | 29.0 |
| " " acetate | $n$ $C_4H_9O(CH_2)_2OCOCH_3$ | 32.0 |
| " " laurate | $n$ $C_4H_9O(CH_2)_2OCO(CH_2)_{10}CH_3$ | 20.6 |
| Tetra hydro furfuryl ether of butyl cellosolve | $(C_4H_7O)CH_2O(CH_2)_2O$-$n$ $C_4H_9$ | 28.2 |
| Tetra hydro furfuryl cellosolve acetate | $(C_4H_7O)CH_2O(CH_2)_2OCOCH_3$ | 30.4 |
| Methyl carbitol acetate | $CH_3O(CH_2CH_2O)_2COCH_3$ | 30.8 |
| Butyl carbitol chloride | $n$ $C_4H_9(OCH_2CH_2)_2Cl$ | 28.0 |
| Methyl ether of tri ethylene glycol acetate | $CH_3O(CH_2CH_2O)_3COCH_3$ | 30.0 |
| Tetra hydro furfural laurate | $(C_4H_7O)CH_2OCO(CH_2)_{10}CH_3$ | 20.4 |
| " " " acetate | $(C_4H_7O)CH_2OCOCH_3$ | 34.2 |
| α,y-Glycerol dichlor hydrine acetate | $(ClCH_2)_2CHOCOCH_3$ | 26.6 |
| Ethyl laurate | $CH_3(CH_2)_{10}COOC_2H_5$ | 21.2 |
| 2 Ethyl-1-hexanol acetate | $CH_3(CH_2)_3CH(C_2H_5)CH_2OCOCH_3$ | 27.2 |
| Furfuryl acetate | $(C_4H_3O)CH_2OCOCH_3$ | 26.3 |
| Ethyl furoate | $(C_4H_3O)COOC_2H_5$ | 30.2 |
| Furfural | $(C_4H_3O)CHO$ | 27.6 |
| Tetralin | $C_{10}H_{12}$ | 22.8 |
| Decalin | $C_{10}H_{18}$ | 14.2 |
| Benzo tri fluoride | $C_6H_5CF_3$ | 30.0 |
| p Fluoroanisole | $p$ $FC_6H_4OCH_3$ | 30.4 |
| Ethyl ether of diethylene glycol acetate | $C_2H_5O(CH_2CH_2O)_2COCH_3$ | 33.3 |
| Diethyl ether of diethylene glycol | $C_2H_5O(CH_2CH_2O)_2C_2H_5$ | 38.2 |

(1) Vapor pressure of $CH_3Cl$ at 4.5°.
(2) Gms. per 100 gms. solvent at 2203 mm. pressures and 32.2°.

**METHYL CHLORIDE**

Freezing-point data are given for:

$CH_3Cl$ + ($CH_3OH$) Methyl Alcohol (Baume et al, 1914.)
" + $(CH_3)_2O$) Dimethyl Ether " " " "

**BROMO METHIONIC ACID** $CHBr(SO_3H)_2$.

100 gms. $H_2O$ dissolve 344.8 gms. $CHBr(SO_3H)_2$ at 25°. (Backer, 1929.)

**CHLORO METHIONIC ACID** $CHCl(SO_3H)_2 \cdot 2H_2O$.

100 gms. $H_2O$ dissolve 324.0 gms. $CHCl(SO_3H)_2$ at 25°. (Backer, 1929.)

**METHYL IODIDE** $CH_3I$.

A sat. solution of methyl iodide in water at 22° has a $d = 2.18$ and contains 0.625 vol. % or 1.362 wt. % $CH_3I$. (Fuhner, 1924.)

100 gms. $H_2O$ dissolve 0.0101 gm. mol. = 1.433 gm. $CH_3I$ at 30°.
(Van Arkel and Vles, 1936.)

Freezing-point data are given for:

$CH_3I$ + $CH_3OH$ (Methyl alcohol) (Baume and Tykociner, 1914.)
$CH_3I$ + $NO_2$ (Nitrogen peroxide) (Pascal, 1923.)
" + $C_5H_5N$ (Pyridine) (Aten, 1905-06.)

**FORMAMIDE** $HCONH_2$.

SOLUBILITY IN WATER, DETERMINED BY THE FREEZING-POINT METHOD.
(English and Turner, 1915.)

| t° of Solidif. | Gms. $HCONH_2$ per 100 Gms. $H_2O$. | Solid Phase. | t° of Solidif. | Gms. $HCONH_2$ per 100 Gms. $H_2O$. | Solid Phase. | t° of Solidif. | Gms. $HCONH_2$ per 100 Gms. $H_2O$. | Solid Phase. |
|---|---|---|---|---|---|---|---|---|
| −0 | 0 | Ice | −31.1 | 116.4 | Ice | −37.6 | 267 | $HCONH_2$ |
| −2.7 | 9.93 | " | −42.5 | 169 | " | −29.4 | 369.8 | " |
| −5.7 | 17.87 | " | −45.4 | 187.8 | $HCONH_2.H_2O$ | −21.9 | 540.3 | " |
| −11 | 35.45 | " | −40.4 | 218.3 | " | −14.5 | 836.8 | " |
| −23.6 | 81.93 | " | −40 | 241.4 | " | − 6.4 | 1780 | " |

Similar data are also given for formamide + formic acid and formamide + propionic acid.

SOLUBILITY OF FORMAMIDE IN METHYL ALCOHOL
DETERMINED BY THE FREEZING-POINT METHOD.
(Joukovsky, 1934.)

| t° | Gms. $HCONH_2$ per 100 gms. mixture | Solid Phase | t° | Gms. $HCONH_2$ per 100 gms. Mixture | Solid Phase |
|---|---|---|---|---|---|
| − 98.4 | 0.0 | $CH_3OH$ | | | |
| −103.1 (Eutec) | 12.9 | " + $HCONH_2$ | −44.2 | 49.1 | $HCONH_2$ |
| − 75.3 | 25.6 | $HCONH_2$ | −34.6 | 59.9 | " |
| − 65.6 | 31.7 | " | −12.7 | 83.8 | " |
| − 61.5 | 34.7 | " | + 2.5 | 100.0 | " |

RECIPROCAL SOLUBILITY OF FORMAMIDE AND NITROBENZENE.
(Joukovsky, 1934.)

| t° | Gms. $HCONH_2$ per 100 gms. mixture | t° | Gms. $HCONH_2$ per 100 gms. mixture | t° | Gms. $HCONH_2$ per 100 gms. mixture |
|---|---|---|---|---|---|
| 60 | 5.2 | 108.2* | 36.8 | 81 | 70.40 |
| 84 | 8.1 | 107.6 | 43.1 | 19.2 | 76.0 |
| 102.8 | 16.8 | 107.6 | 44.7 | — | 90.0 |
| 104.2 | 18.7 | 107.0 | 45.6 | | |

* Critical solution temperature

Results for this system in terms of volume percent of the liquids are given by Jänecke, 1939. This author also gives complete results for the ternary system Formamide + Nitrobenzene + Hexane.

Freezing-point data are given for:

| | |
|---|---|
| $HCONH_2$ + $CH_3COOH$ (Acetic acid) | (English and Turner, 1915.) |
| " + n $C_3H_7COOH$ (n Butyric acid) | " " " |
| " + $CS_2$ (Carbon Disulfide) | (Joukovsky, 1934.) |
| " + $(C_2H_5)_2O$. (Ethyl Ether) | " " |
| " + $C_6H_6$ (Benzene) | " " |
| " + $C_6H_5NO_2$ (Nitro benzene) | " " |

**NITRO METHANE** $CH_3NO_2$.

Reciprocally saturated layers of nitromethane and water were each analyzed by means of viscosity measurements.

100 gms. sat. solution of nitro methane in water (upper layer) contain 10 gms. $C_6H_5NO_2$ at 25°.

100 gms. sat. solution of water in nitro methane (lower layer) contain 2 gms. $H_2O$ at 25°. (Wright, Murray-Rust and Hartley, 1931.)

Determinations of the total and partial vapor pressures of mixtures of nitro methane and methyl alcohol and of nitro methane and ethyl ether at 20.5° are given by Joukovsky, 1934.)

Freezing-point data are given by Joukovsky, 1934, for:

| | |
|---|---|
| $CH_3NO_2$ + $HCOOH$ | (Formic Acid) |
| " + $C_6H_6$ | (Benzene) |
| " + $C_6H_5NO_2$ | (Nitro benzene) |

The critical solution temperature of mixtures of Nitro methane and Tetra chlor ethylene is 41°. (Cornish, Archibald, Murphy and Evans, 1934.)

The limit of the reciprocal solubility of Nitro methane and:

Prim. i- Butanol is at 56.5 percent nitro methane and 17.0°.
i - Butyl carbinol is at 87.5 percent nitro methane and 13.5°.
Dimethyl ethyl carbinol is at 49.5 percent nitro methane and about 3°.
(Lecat, 1930.)

**METHANE** $CH_4$.

SOLUBILITY IN WATER.
(Winkler, 1901.)

| t°. | β. | β'. | q. | t°. | β. | β'. | q. |
|---|---|---|---|---|---|---|---|
| 0 | 0.05563 | 0.05530 | 0.00396 | 40 | 0.02369 | 0.02198 | 0.00159 |
| 5 | 0.04805 | 0.04764 | 0.00341 | 50 | 0.02134 | 0.01876 | 0.00136 |
| 10 | 0.04177 | 0.04127 | 0.00296 | 60 | 0.01954 | 0.01571 | 0.00115 |
| 15 | 0.03690 | 0.03628 | 0.00260 | 70 | 0.01825 | 0.01265 | 0.00093 |
| 20 | 0.03308 | 0.03233 | 0.00232 | 80 | 0.01770 | 0.00944 | 0.00070 |
| 25 | 0.03006 | 0.02913 | 0.00209 | 90 | 0.01735 | 0.00535 | 0.00040 |
| 30 | 0.02762 | 0.02648 | 0.00191 | 100 | 0.01700 | 0 | 0 |

β = Bunsen Absorption Coefficient, which is the volume of gas (reduced to 0° and 760 mm) dissolved by 1 volume of the liquid when the partial pressure of the gas is 760 mm.
β' = is the same as β, except the measurements are at the total pressure of the gas plus liquid instead of at the partial pressure of the gas alone.
q = the weight of gas in grams dissolved by 100 gms. of pure solvent at the indicated temperature and total pressure of 760 mm.

SOLUBILITY OF METHANE IN AQUEOUS SOLUTIONS OF SULFURIC ACID AT 20°.
(Christoff, 1906.)

| Gms. $H_2SO_4$ per 100 gms. aq. solvent | Gm. Mol. $H_2SO_4$ per liter solvent | β | l |
|---|---|---|---|
| 35.82 | 4.64 | 0.01691 | 0.01815 |
| 61.62 | 9.55 | 0.01311 | 0.01407 |
| 95.6 | 18.0 | 0.03072 | 0.03303 |

β = Bunsen Absorption Coefficient
$l$ = Ostwald Solubility Expression, which is the ratio of the volume (v) of gas absorbed at any pressure and temperature to the volume (V) of the absorbing liquid, i.e. $l = \frac{v}{V}$. This expression differs from the Bunsen Absorption Coefficient β, in that the volume V of the dissolve gas is not reduced to 0° and 760 mm. The solubility $l$ is therefore the volume of gas dissolved by unit volume of solvent at the temperature of the experiment. The two expressions are related thus:

$$l = \beta(1 + 0.00367t), \qquad \beta = \frac{l}{(1 + 0.00367\ t)}$$

Using a special apparatus which permitted the agitation of a sample of air containing a known percentage of Pittsburgh natural gas (composed of 90 % $CH_4$ + 10 % $C_2H_6$) with water, and the removal of the sample for analysis after the period of contact with the water, the solubility coefficient $\alpha_{25}$ (= the volume of gas reduced to 0° dissolved by 1 vol. of $H_2O$ at 25°, when the pressure of the gas over the water is 760 mm.) was found to be 0.032. (Milligan, 1924.)

## Solubility of Mine Gas (79.4 % $CH_4$ + 17.1 % $N_2$ + 2.8 % $O_2$ + 0.7 % $CO_2$) in Water and Organic Solvents Under Pressure.

(Fischer and Zerbe, 1923.)

An autoclave of 330 cc. capacity was used. Into this was placed 100 cc. of solvent and mine gas from a steel cylinder untill a pressure of about 20 atmospheres was reached. The autoclave was then shaken at about 20° for $^1/_2$ hour. The pressure was then lowered to 1 atmosphere and a weighed amount of the solution analyzed for its contained gas. The results showed that although much nitrogen was present the absorbed gas contained the several constituents in approximately the same ratio as the used mine gas.

The author was interested principally in comparative values for various solvents.

| Used solvent. | Cc. Gas dissolved by 1 vol. of solvent. | Used solvent, | Cc. Gas dissolved by 1 vol. of solvent. |
|---|---|---|---|
| Water | 0.09 | Acetone | 0.61 |
| Petroleum ether (b. pt. 65°) | 1.34 | Ethyl acetate | 0.45 |
| » ( » 65–100) | 0.84 | Chloroform | 0.32 |
| » ( » 100–150) | 0.66 | Carbon disulfide | 0.36 |
| Petroleum | 0.56 | Benzene | 0.51 |
| Paraffine oil | 0.44 | Xylene | 0.53 |
| Methyl alcohol | 0.46 | Aniline | 0.16 |
| Ethyl alcohol | 0.60 | Nitrobenzene | 0.16 |
| Amyl alcohol | 0.44 | Tri cresol | 0.26 |
| Ethyl ether | 0.91 | Coal tar hydrocarbon (250-300) | 0.40 |

100 cc. $H_2O$ dissolve 3.2 cc. Methane (0° and 760 mm) at 21°.
» Rubber » 26.8 cc. » » »

The gas dissolved by a given amount of air free rubber was pumped out with a Töpler pump and measured over mercury. Data are also given for the effect of temperature and pressure and for the relation between solubility and penetrability.

(Venable and Fuwa, 1922.)

## Solubility of Methane in Methyl Alcohol and in Acetone.

(Levi, 1901, 1902.)

In methyl alcohol $l$ (Ostwald expression, see page 37 ) = $0.5644 - 0.0046\,t - 0.00004\,t^2$.

In acetone $l$ (Ostwald expression) = $0.5906 - 0.00613\,t - 0.000046\,t^2$.

From which are calculated the following values:

| In Methyl Alcohol. | | | | In Acetone. | | | |
|---|---|---|---|---|---|---|---|
| t°. | l. | t°. | l. | t°. | l. | t°. | l. |
| 0 | 0.5644 | 40 | 0.3164 | 0 | 0.5906 | 40 | 0.2718 |
| 10 | 0.5144 | 50 | 0.2344 | 10 | 0.5247 | 50 | 0.1691 |
| 20 | 0.4564 | 60 | 0.1444 | 20 | 0.4496 | 60 | 0.0572 |
| 30 | 0.3904 | 70 | 0.0464 | 30 | 0.3653 | | |

## Solubility of Methane in Ethyl Alcohol.

(Bunsen, 1877, 1892.)

| t°. | 2°. | 6.4°. | 11°. | 15°. | 19°. | 23.5°. |
|---|---|---|---|---|---|---|
| Abs. coef. $\beta$ (found) | 0.51721 | 0.50382 | 0.49264 | 0.48255 | 0.4729 | 0.4629 |

from which the following formula was calculated.

Bunsen abs. coef. $\beta$ for methane = $0.522745 - 0.00295882\,t - 0.0000177\,t^2$.

## The Solubility of Methane in Water and in Organic Solvents at 25° and at Pressures up to 140 Atmospheres.

(Frolich, Tauch, Hogan and Peer, 1931.)

The determinations were made by shaking methane and each of the several solvents at various pressures in a steel cylinder maintained at 25° and, after attainment of equilibrium, withdrawing a sample of the mixture over mercury in one of three burets so designed that the volume could be measured with the same degree of accuracy at any ratio of gas to liquid. The results are given only in the form of a diagram from which the following approximate values were estimated.

| Solvent | cc $CH_4$ (reduced to 25° and 760 mm) dissolved by 1.0 cc solvent at: | | | | | |
|---|---|---|---|---|---|---|
| | 20 | 40 | 60 | 80 | 100 | 140 Atmospheres |
| Water | 0.9 | 1.2 | 1.8 | 2.0 | 2.6 | 3.3 |
| Methanol (1) | 9.0 | 19.0 | 29.5 | 41.0 | 55.0 | — |
| Ethanol | 7.5 | 14.5 | 21.5 | 29.5 | 38.0 | 48.0 (120 Atm.) |
| Propane | 41 | 83 | 125 | 174 | 200 (90 Atm.) | — |
| Butane | 37 | 71 | 107 | 144 | — | — |
| Pentane | 33 | 63 | 97 | 129 | 164 | — |
| Hexane | 30 | 59 | 89 | 120 | — | — |
| Octane | 24 | 51 | 80 | 110 | 140 | — |
| Cyclohexane | 15 | 33 | 56 | 83 | — | — |
| Benzene | 11 | 24 | 41 | 59 | 80 | — |
| Heavy Naphtha | 10 | 20 | 31 | 43 | — | — |
| Gas Oil | 8 | 16 | 23 | 32 | 41 | 62 |

(1) The solubility of methane in n propanol, iso propanol, n butanol and iso butanol is, within experimental error, the same as in methanol.

### Solubility of Methane in Several Alcohols and Other Solvents.

(McDaniel, 1911.)

| Solvent. | t°. | Abs. Coef. *A*. | Bunsen Coef. $\beta$. | Solvent. | t°. | Abs. Coef. *A*. | Bunsen Coef. $\beta$. |
|---|---|---|---|---|---|---|---|
| Alcohol: | | | | | | | |
| Methyl (99%) | 22.1 | 0.4436 | 0.4102 | Toluene | 40.1 | 0.4675 | 0.4080 |
| " | 30.2 | 0.4278 | 0.3883 | " | 50.2 | 0.4545 | 0.4013 |
| " | 40 | 0.3938 | 0.3436 | " | 60 | 0.4502 | 0.3690 |
| " | 49.8 | 0.2695 | 0.2278 | *m* Xylene | 21.1 | 0.5146 | 0.4778 |
| Ethyl (99.8%) | 22.2 | 0.4628 | 0.4282 | " | 30.5 | 0.5028 | 0.4529 |
| " | 30.1 | 0.4503 | 0.4051 | " | 50 | 0.4972 | 0.4203 |
| " | 40 | 0.4323 | 0.3771 | " | 60 | 0.4870 | 0.3992 |
| Isopropyl | 21.5 | 0.4620 | 0.4275 | Hexane | 22.2 | 0.6035 | 0.5585 |
| " | 29.9 | 0.4532 | 0.4081 | " | 40.2 | 0.5320 | 0.4639 |
| " | 40 | 0.4400 | 0.3837 | " | 49.7 | 0.5180 | 0.4380 |
| " | 60.3 | 0.4244 | 0.3478 | " | 60 | 0.4964 | 0.4068 |
| Amyl | 22 | 0.4532 | 0.4196 | Heptane | 22.2 | 0.7242 | 0.6720 |
| " | 30.1 | 0.4444 | 0.4002 | " | 30.1 | 0.6906 | 0.6221 |
| Benzene | 22.1 | 0.4954 | 0.4600 | " | 40 | 0.6675 | 0.5820 |
| " | 35 | 0.4484 | 0.3976 | Pinene* | 20 | 0.4888 | 0.4565 |
| " | 40.1 | 0.4198 | 0.3661 | " | 30.1 | 0.4620 | 0.4163 |
| " | 49.9 | 0.3645 | 0.3081 | " | 39.1 | 0.4472 | 0.3914 |
| Toluene | 25 | 0.4852 | 0.4450 | " | 45 | 0.4440 | 0.3811 |
| " | 30 | 0.4778 | 0.4300 | " | 55.2 | 0.3694 | 0.3076 |

* b. pt. 155–160°.

Abs. coef. *A* = vol. of methane absorbed by unit vol. of solvent at temp stated.

For definition of Bunsen abs. coef. $\beta$ see page 37.

## Solubility of Methane in Several Organic Solvents at Various Temperatures.

(Horiuti, 1931.)

| t° | Solubility of $CH_4$ in terms of the Ostwald Solubility Expression $l$, in: | | | | | |
|---|---|---|---|---|---|---|
| | $CCl_4$ | $(CH_3)_2CO$ | $(C_2H_5)_2O$ | $CH_3COOCH_3$ | $C_6H_6$ | $C_6H_5Cl$ |
| -80.4 | — | — | 2.220 | — | — | — |
| -76.7 | — | 0.8726 | 2.119 | 0.7571 | — | — |
| -60.6 | — | 0.7699 | 1.754 (4) | 0.6926 | — | — |
| -41.6 | — | 0.6943 | 1.476 | 0.6454 | — | 0.5703(-40.8) |
| -20.4 | 0.8109 (1) | 0.6513 (2) | 1.275 | 0.6203 | — | 0.5259 |
| 0 | 0.7621 | 0.6232 | 1.157 | 0.6068 | 0.5687 (3) | 0.4976 |
| +20 | 0.7271 | 0.6165 | 1.078 | 0.6032 | 0.5680 | 0.4808 |
| 40 | 0.7031 | 0.6101 | — | 0.5987 | 0.5697 | 0.4728 |
| 60 | 0.6876 | — | — | — | 0.5787 | 0.4748 (5) |

(1) =-19.8°; (2) =-21.8°; (3) = 13.1°; (4) =-61.6°; (5) = 99.6°.

Results for the solubility of $CH_4$ in $(C_2H_5)_2O$, reported by Christoff, 1912, in terms of the Ostwald Solubility Expression, are $l$ = 1.066 at 0° and 1.028 at 10°.

## Solubility of Methane in Several Solvents at Pressures Less than One Atmosphere.

(Kirjeew and Romantchouk, 1936.)

| Solvent | Gas Pressure in mm Hg | cc $CH_4$ (at 0° and 760 mm) dissolved by 1 cc solvent at: | | | | |
|---|---|---|---|---|---|---|
| | | -20° | -10° | 0° | +20° | +40° |
| Petrol (Gasoline?) | 50 | 0.040 | 0.035 | 0.035 | 0.030 | 0.015 |
| " " | 100 | 0.085 | 0.080 | 0.070 | 0.060 | 0.040 |
| " " | 200 | 0.170 | 0.155 | 0.145 | 0.120 | 0.085 |
| " " | 300 | 0.255 | 0.240 | 0.220 | 0.180 | 0.130 |
| " " | 400 | 0.340 | 0.320 | 0.300 | 0.240 | 0.175 |
| " " | 500 | 0.420 | 0.400 | 0.375 | 0.300 | 0.220 |
| " " | 600 | 0.515 | 0.498 | 0.455 | 0.365 | 0.265 |
| " " | 700 | 0.595 | 0.562 | 0.530 | 0.425 | 0.310 |
| " " | 760 | 0.650 | 0.610 | 0.575 | 0.460 | 0.340 |
| Xylene | 50 | 0.050 | 0.045 | 0.040 | 0.035 | 0.030 |
| " | 100 | 0.100 | 0.090 | 0.085 | 0.070 | 0.055 |
| " | 200 | 0.195 | 0.185 | 0.172 | 0.150 | 0.110 |
| " | 300 | 0.290 | 0.275 | 0.260 | 0.220 | 0.160 |
| " | 400 | 0.390 | 0.370 | 0.350 | 0.295 | 0.220 |
| " | 500 | 0.485 | 0.460 | 0.435 | 0.370 | 0.270 |
| " | 600 | 0.580 | 0.555 | 0.520 | 0.445 | 0.320 |
| " | 700 | 0.680 | 0.645 | 0.610 | 0.520 | 0.375 |
| " | 760 | 0.740 | 0.700 | 0.660 | 0.565 | 0.410 |
| Cracking Benzene(?) | 50 | 0.065 | 0.060 | 0.050 | 0.040 | 0.020 |
| " " | 100 | 0.130 | 0.130 | 0.100 | 0.080 | 0.060 |
| " " | 200 | 0.225 | 0.260 | 0.205 | 0.170 | 0.125 |
| " " | 300 | 0.385 | 0.340 | 0.305 | 0.250 | 0.180 |
| " " | 400 | 0.515 | 0.450 | 0.405 | 0.340 | 0.250 |
| " " | 500 | 0.640 | 0.565 | 0.510 | 0.425 | 0.310 |
| " " | 600 | 0.770 | 0.675 | 0.610 | 0.505 | 0.370 |
| " " | 700 | 0.895 | 0.790 | 0.710 | 0.590 | 0.435 |
| " " | 760 | 0.975 | 0.855 | 0.770 | 0.640 | 0.470 |

### Solubility of Methane in Dichloro Ethane and in Heavy Solvent at 0° and Various Pressures.

(Kirjeew and Romantchouk, 1936.)

| Solvent | cc $CH_4$ (at 0° and 760 mm) dissolved by 1 cc solvent at 0° and at a pressure of: 50 | 100 | 200 | 400 | 600 | 760 mm Hg. |
|---|---|---|---|---|---|---|
| Dichloro Ethane | 0.020 | 0.045 | 0.080 | 0.105 | 0.245 | 0.310 |
| Heavy Solvent | 0.025 | 0.050 | 0.095 | 0.190 | 0.280 | 0.355 |

1000 cc cyclohexanol ($C_6H_{11}OH$) dissolve 133.3 cc $CH_4$ at 26° and 765 mm Hg pressure. (Cauquil, 1927.)

The coef. of absorption $\beta$ (Bunsen) of methane in petroleum (Russian) is 0.144 at 10° and 0.131 at 20°. (Gniewosz and Walfisz, 1887.)

Determinations of the pressure—composition—temperature equilibrium in the systems

Methane + Ethane
" + Ethylene
" + Ethane + Ethylene

are given by Ruhemann, 1939, and Guter, Newitt and Ruhemann, 1940.

Determinations of the equilibrium in the systems: Methane + Pentane, Methane + Hexane and Methane + Heptane, at various temperatures and under pressures between 35 and 250 atmospheres, are given by Boomer, Johnson and Piercey, 1938.

## THIOUREA $CS(NH_2)_2$.

### Solubility of Thiourea in Water.

The fairly closely agreeing results of Oliveri-Mandala and Irrera, 1930; Jänecke and Hoffmann, 1932 and Shnidman, 1933, were plotted and the following average values taken from the curve.

| t° | Gms. $CS(NH_2)_2$ per 100 gms. sat. sol. | t° | Gms. $CS(NH_2)_2$ per 100 gms. sat. sol. | t° | Gms. $CS(NH_2)_2$ per 100 gms. sat. sol. |
|---|---|---|---|---|---|
| -5 | Eutec. 3.0 | 40 | 23.5 | 100 | 70.5 |
| 0 | 4.7 | 50 | 32.5 | 120 | 80.7 |
| 10 | 8.0 | 60 | 41.5 | 140 | 89.2 |
| 20 | 12.0 | 70 | 50.5 | 160 | 95.5 |
| 25 | 14.2 | 80 | 58.0 | 180 | 100.0 |
| 30 | 16.7 | 90 | 64.5 | | |

Results for the vapor pressures at various temperatures and the boiling-points of aqueous thiourea solutions at atmospheric pressure are given by Jänecke and Hoffmann, 1932.

Freezing-point data for mixtures of thiourea and water are given by Kettner, 1919.

## Solubility of Thiourea in Aqueous Solutions of Ammonia.

(Jänecke and Hoffmann, 1932.)

The determinations were for the most part made by observing the temperature of complete solubility on slowly warming mixtures of known amounts of the constituents contained in ampules or shaking flasks.

| t° | Gms. per 100 gms. mixture | | t° | Gms. per 100 gms. mixture | | t° | Gms. per 100 gms. mixture | |
|---|---|---|---|---|---|---|---|---|
| | $H_2O$ | $NH_3$ | | $H_2O$ | $NH_3$ | | $H_2O$ | $NH_3$ |
| -33 | 14.3 | 55.6 | 26.5 | 10.1 | 30.0 | 65.0 | 15.8 | 21.4 |
| -31 | 42.6 | 43.4 | 28.7 | 51.4 | 19.2 | 66.0 | 48.4 | 4.1 |
| -26.1 | 29.3 | 42.5 | 29.2 | 70.0 | 9.7 | 66.8 | 46.1 | 4.8 |
| -20.9 | 10.4 | 50.2 | 30 | 70.5 | 7.8 | 68.2 | 40.3 | 7.7 |
| -10.9 | 32.6 | 44.4 | 30 | 59.3 | 13.1 | 69.8 | 8.3 | 22.2 |
| - 8.9 | 43.5 | 35.5 | 35.9 | 78.5 | 0.8 | 71.7 | 35.0 | 9.5 |
| 0 | 83.4 | 9.3 | 38.6 | 29.4 | 23.2 | 75.0 | 43.1 | 3.2 |
| 0 | 73.2 | 16.1 | 41.5 | 61.1 | 9.4 | 80.4 | 29.5 | 8.5 |
| + 1.4 | 75.5 | 14.9 | 42 | 16.5 | 24.6 | 83.0 | 11.5 | 17.2 |
| 7.5 | 11.5 | 42.0 | 45 | 16.2 | 23.7 | 87.1 | 3.2 | 19.1 |
| 10 | 80.1 | 8.9 | 45 | 51.2 | 11.2 | 89.6 | 27.0 | 6.2 |
| 10 | 70.0 | 15.4 | 45 | 63.6 | 7.1 | 94.2 | 16.8 | 11.1 |
| 12.5 | 22.8 | 29.7 | 48.0 | 40.6 | 16.4 | 103.0 | 18.6 | 8.3 |
| 17.5 | 36.0 | 26.4 | 55.6 | 5.3 | 26.1 | 105.9 | 25.6 | 2.4 |
| 18.0 | 64.9 | 18.3 | 56.1 | 18.9 | 21.9 | 108.5 | 5.1 | 14.2 |
| 20 | 76.0 | 8.5 | 56.4 | 52.8 | 5.1 | 114.2 | 12.3 | 7.7 |
| 20 | 65.5 | 14.4 | 64.8 | 34.6 | 12.6 | 139.0 | 2.7 | 8.4 |
| | | | | | | 147.8 | 1.3 | 6.8 |

10 cc sat. solution of thiourea in cold aqueous saturated magnesium perchlorate, $Mg(ClO_4)_2$, contain 0.7 gm. $CS(NH_2)_2$. (Duclaux and Durand-Gasselin, 1938.

## Solubility of Thiourea in Aqueous Solutions of Antipyrine.

(Oliveri-Mandala and Irrera, 1930.)

Results at 15°

| Gms. per 100 gms. sat. sol. | |
|---|---|
| Antipyrine | $CS(NH_2)_2$ |
| 0.0 | 10.538 |
| 0.193 | 0.389 |
| 3.638 | 13.742 |
| 5.682 | 17.338 |

Results at 25°

| Gms. per 100 gms. sat. sol. | |
|---|---|
| Antipyrine | $CS(NH_2)_2$ |
| 0.0 | 13.394 |
| 0.193 | 0.445 |
| 3.638 | 16.570 |
| 5.682 | 20.904 |

### Solubility of Thiourea in Liquid Ammonia.
(Jänecke and Hoffmann, 1932.)

| t° | Gms. $CS(NH_2)_2$ per 100 gms. sat. sol. | Solid Phase | t° | Gms. $CS(NH_2)_2$ per 100 gms. sat. sol. | Solid Phase |
|---|---|---|---|---|---|
| -78 | 0 | $NH_3$ | +2.0 | 54.3 | $CS(NH_2)_2.NH_3$ |
| -71.8 | 11.3 | $CS(NH_2)_2.3NH_3$ | 6.2 | 58.2 | " |
| -68.0 | 12.7 | " | 11.8 | 61.2 | $CS(NH_2)_2$ |
| -55.5 | 18.0 | " | 30.0 | 64.9 | " |
| -37.1 | 27.2 | " | 40.3 | 69.6 | " |
| -32.8 | 32.2 | " | 98.7 | 81.6 | " |
| -19.9 | 40.7 | " | 111.0 | 83.9 | " |
| -15.0 | 44.5 | " | 127.0 | 87.4 | " |
| -12.0 | 50.7 | " | 152.0 | 93.9 | " |
| -10 | 50.0 | $CS(NH_2)_2.NH_3$ | 181.0 | 100.0 | " |

100 gms. sat. sol. of thiourea in liquid ammonia contain 37 gms. $CS(NH_2)_2$ at room temp. (?)(DeCarli, 1927.)

100 gms. Pyridine dissolve 12.5 gms. thiourea at 20-25°.

100 gms. aq. 50% Pyridine dissolve 41.2 gms. thiourea at 20-25°.
(Dehn, 1917.)

### Solubility of Thiourea in Methyl and in Ethyl Alcohol.
(Schmidman, 1933.)

The determinations were made by the synthetic, sealed tube, method. The end point was that at which the solid phase had nearly disappeared.

| Results for Methyl Alcohol | | | Results for Ethyl Alcohol | | |
|---|---|---|---|---|---|
| t° | Gms. $CS(NH_2)_2$ per 100 gms. sat. sol. | Mol. Fraction $CS(NH_2)_2$ | t° | Gms. $CS(NH_2)_2$ per 100 gms. sat. sol. | Mol. Fraction $CS(NH_2)_2$ |
| 25.11 | 11.95 | 0.0540 | 20.25 | 3.61 | 0.0221 |
| 40.80 | 16.37 | 0.0760 | 31.99 | 4.69 | 0.0289 |
| 53.76 | 22.01 | 0.0999 | 37.69 | 5.40 | 0.0334 |
| 62.00 | 24.56 | 0.1205 | 45.14 | 6.33 | 0.0393 |
| | | | 51.22 | 7.21 | 0.0449 |
| | | | 58.05 | 8.48 | 0.0531 |
| | | | 64.77 | 9.81 | 0.0618 |

## METHYL ALCOHOL $CH_3OH$.

### Freezing-points of Mixtures of Methyl Alcohol and Water.

The previous results of Pickering, 1893, Baumé and Borowski, 1914, and Benjamin, 1932, are in good agreement with the later determinations of Ewart, 1937. The results of Pushin and Glagoleva, 1922, are apparently erroneous. The following values are from the curve given by Ewart.

| t° | Gm. Mol. $CH_3OH$ per 100 gm. mol. mixture | Solid Phase | t° | Gm. Mol. $CH_3OH$ per 100 gm. mol. mixture | Solid Phase |
|---|---|---|---|---|---|
| - 5 | 5.0 | Ice | -105.5 | 60.0 | $CH_3OH.H_2O$ |
| - 20 | 15.0 | " | -110 | 66 | " |
| - 35 | 25.0 | " | -117.5 | 70 | " |
| - 52.5 | 35.0 | " | -125 (Eutec.) | 72 | " + $CH_3OH$ |
| - 72 | 45.0 | " | -117 | 80 | $CH_3OH$ |
| - 85 | 50.0 | " | -110 | 86 | " |
| -104.5(tr.pt.) | 55 | " + $CH_3OH.H_2O$ | - 98 | 100 | " |

## Freezing-points of Mixtures of Methyl Alcohol, Ethyl Alcohol, and Water.

(Aldrich, and Querfeld, 1931.)

The mixtures were made by diluting accurately measured volumes of the alcohols at 15.6° with water to a total volume of 100 cc at 15.6°. The The concentrations are thus the volume percent of total alcohol present. The freezing-points are the averages of the temperature at which the first crystal appeared and that at which it just disappeared.

| Vol. Percent $CH_3OH$ in Alcohol mixture | Freezing-point of aqueous Mixture Containing: | | | | | |
|---|---|---|---|---|---|---|
| | 10 Vol.% | 20 Vol. % | 30 Vol. % | 40 Vol. % | 50 Vol. % | 60 Vol. % $CH_3OH$ + $C_2H_5OH$ |
| 0 | -3.6 | - 8.6 | -15.1 | -22.7 | -30.7 | -38.8 |
| 12.5 | -3.7 | - 8.8 | -15.6 | -23.7 | -32.3 | -41.1 |
| 25.0 | -3.8 | - 9.1 | -16.1 | -24.6 | -33.8 | -43.4 |
| 33.3 | -3.9 | - 9.3 | -16.5 | -25.2 | -34.8 | -44.9 |
| 50.0 | -4.1 | - 9.6 | -17.2 | -26.4 | -36.8 | -48.0 |
| 66.7 | -4.3 | -10.0 | -17.0 | -27.7 | -38.9 | -51.1 |
| 75.0 | -4.4 | -10.2 | -18.2 | -28.4 | -39.9 | -52.7 |
| 87.5 | -4.5 | -10.3 | -18.8 | -29.3 | -41.4 | -55.6 |
| 100.0 | -4.6 | -10.7 | -19.3 | -30.2 | -43.0 | -57.3 |

The authors also give results for the boiling points of the above mixtures.

## Freezing-points of Mixtures of Methyl Alcohol, Glycerol and Water.

(Feldman and Dahlstrom, 1936.)

A series of mixtures of $CH_3OH$ + $C_3H_5(OH)_3$ were prepared by weighing and for each determination weighed amounts of these were added to weighed amounts of water. The freezing-point was taken as the temperature at which the last crystal disappeared on slow warming. The results were plotted and the following values for regular intervals of composition of the mixtures were taken from the curve.

| Gms. $CH_3OH$ per 100 gms. $CH_3OH+C_3H_5(OH)_3$ Mixture(A) | Freezing-points of Mixtures Composed of: | | | | |
|---|---|---|---|---|---|
| | 90 Wt. % $H_2O$ + 10 Wt. % (A) | 80 Wt. % $H_2O$ + 20 Wt. % (A) | 70 Wt. % $H_2O$ + 30 Wt. % (A) | 60 Wt. % $H_2O$ + 40 Wt. % (A) | 50 Wt. % $H_2O$ + 50 Wt. % (A) |
| 0 | -1.9 | - 5.4 | - 9.7 | -15.6 | -23.6 |
| 12.2 | -2.5 | - 6.5 | -11.5 | -18.8 | -28.8 |
| 20.4 | -3.2 | - 7.7 | -13.5 | -21.5 | -32.7 |
| 30.3 | -3.2 | - 8.5 | -15.5 | -23.9 | -35.5 |
| 39.1 | -4.2 | -10.0 | -17.5 | -26.5 | -39.2 |
| 49.6 | -4.2 | -10.2 | -18.2 | -29.2 | -42.8 |
| 60.5 | -5.2 | -12.1 | -20.5 | -32.5 | -46.7 |
| 69.8 | -5.5 | -12.5 | -21.0 | -33.7 | -47.5 |
| 81.2 | -6.0 | -13.8 | -23.5 | -36.2 | -50.0 |
| 89.3 | -6.2 | -14.2 | -24.5 | -37.8 | -51.5 |
| 100.0 | -6.3 | -15.2 | -26.5 | -39.8 | -53.2 |

The previous results of Olsen, Brunjes and Olsen, 1930, for $H_2O$ + $CH_3OH$ and for $H_2O$ + $C_3H_5(OH)_2$, and of Aldrich and Overfeld, 1931 for $H_2O$ + $CH_3OH$ differ slightly from the present values.

## Miscibility of Methyl Alcohol at 0° with Mixtures of:

Carbon Tetrachloride and Water. (Bonner, 1910.) Chloroform and Water. (Bonner, 1910.)

| Composition of Homogeneous Mixtures. | | | | Composition of Homogeneous Mixtures. | | | |
|---|---|---|---|---|---|---|---|
| Gms. $CCl_4$. | Gms. $H_2O$. | Gms. $CH_3OH$. | Sp. Gr. of Mixture. | Gms. $CHCl_3$. | Gms. $H_2O$. | Gms. $CH_3OH$. | Sp. Gr. of Mixture. |
| *0.985 | 0.015 | 0.215 | ... | 0.979 | 0.021 | 0.161 | ... |
| 0.974 | 0.026 | 0.328 | 1.30 | 0.90 | 0.10 | 0.35 | 1.17 |
| 0.90 | 0.10 | 0.74 | 1.13 | 0.80 | 0.20 | 0.49 | 1.12 |
| 0.80 | 0.20 | 1.10 | 1.04 | *0.73 | 0.27 | 0.57 | ... |
| 0.70 | 0.30 | 1.40 | 1 | 0.70 | 0.30 | 0.60 | 1.08 |
| 0.60 | 0.40 | 1.68 | 0.97 | 0.60 | 0.40 | 0.70 | 1.05 |
| 0.50 | 0.50 | 1.71 | 0.95 | 0.50 | 0.50 | 0.77 | 1.02 |
| 0.40 | 0.60 | 1.77 | 0.93 | 0.40 | 0.60 | 0.83 | 1 |
| 0.20 | 0.80 | 1.88 | 0.92 | 0.20 | 0.80 | 0.84 | 0.97 |
| 0.10 | 0.90 | 1.90 | 0.92 | 0.10 | 0.90 | 0.74 | 0.96 |
| 0.026 | 0.974 | 1.045 | 0.93 | 0.013 | 0.987 | 0.267 | 0.98 |

NOTE.—The above determinations were made by gradually adding methyl alcohol to mixtures of given amounts of water and the other constituent until a homogeneous solution was obtained. The results give the binodal curve of the system. The author also determined "tie lines" showing the composition of each of two layers in contact with each other. These tie lines become shorter as the compositions of the pairs of liquids approach each other and finally are reduced to a point known as the "plait point" of the binodal curve. This point is marked by an * in the above table. The mixtures above and below the * correspond, according to their Sp.Gr., to the upper and lower immicible layers of the system.

## Reciprocal Solubility of Methyl Alcohol, Ethyl Acetate and Water

(Beech and Glastone, 1938.)

The binodal curve was determined by the titration method. The composition of conjugate layers was found by preparing mixtures of known amounts of the three components and analyzing the upper layer for acetate. These results and the solubility curve fixed the tie lines. The points at the extremities of these lines gave the compositions of conjugate layers.

| Gms. per 100 gms. lower layer | | | Gms. per 100 gms. upper layer | | |
|---|---|---|---|---|---|
| $H_2O$ | $CH_3COOC_2H_5$ | $CH_3OH$ | $H_2O$ | $CH_3COOC_2H_5$ | $CH_3OH$ |
| Results at 0° | | | | | |
| 90.4 | 9.6 | 0.0 | 2.3 | 97.7 | 0.0 |
| 85.4 | 9.5 | 5.1 | 2.6 | 97.1 | 0.3 |
| 80.8 | 9.5 | 9.7 | 3.2 | 95.5 | 1.3 |
| 75.5 | 10.2 | 14.3 | 3.7 | 94.1 | 2.2 |
| 72.0 | 11.2 | 16.8 | 4.8 | 91.1 | 3.9 |
| 60.4 | 16.3 | 23.3 | 7.9 | 84.4 | 7.7 |

Results at 20°

| | | | | | |
|---|---|---|---|---|---|
| 92.2 | 7.8 | 0.0 | 2.8 | 97.2 | 0.0 |
| 87.8 | 8.0 | 4.2 | 3.4 | 95.6 | 1.0 |
| 83.0 | 8.4 | 8.6 | 4.3 | 92.6 | 3.1 |
| 79.0 | 9.3 | 11.7 | 5.8 | 88.9 | 5.3 |
| 74.6 | 10.5 | 15.0 | 6.3 | 87.4 | 6.3 |
| 65.2 | 14.5 | 20.3 | 10.2 | 79.8 | 10.0 |
| 55.1 | 21.4 | 23.5 | 15.0 | 71.3 | 13.7 |

The following results for points on the binodal curve of this system at 20° are given by Bancroft, 1895.

| Per 1.0 cc $CH_3OH$ | | Per 1 cc $CH_3OH$ | |
|---|---|---|---|
| cc $H_2O$ | cc $CH_3COOC_2H_5$ | cc $H_2O$ | cc $CH_3COOC_2H_5$ |
| 10 | 1.08 | 1.0 | 4.9 |
| 3 | 0.68 | 0.98 | 7.0 |
| 1.5 | 1.69 | 1.0 | 8.0 |
| 1.29 | 2.50 | 1.03 | 10.0 |

## Reciprocal Solubility of Methyl Alcohol, Ethyl Ether and Water at 20°.

(Bancroft, 1895.)

| Per 1 cc $CH_3OH$ | | Per 1 cc $CH_3OH$ | | Per 1 cc $CH_3OH$ | |
|---|---|---|---|---|---|
| cc $H_2O$ | cc $(C_2H_5)_2O$ | cc $H_2O$ | cc $(C_2H_5)_2O$ | cc $H_2O$ | cc $(C_2H_5)_2O$ |
| 10 | 1.13 | 1.8 | 0.63 | 0.52 | 5.0 |
| 7 | 0.85 | 1.0 | 1.23 | 0.44 | 10.0 |
| 4 | 0.60 | 0.83 | 1.8 | 0.45 | 15.0 |
| 2.5 | 0.56 | 0.64 | 3.0 | | |

## Reciprocal Solubility of Methyl Alcohol Benzene and Water at 20°.

(Perrakis, 1925.)

The amount of water required to produce clouding in various mixtures of methyl alcohol and benzene was determined by a titration method.

| Gms. $CH_3OH$ per 100 gms. $CH_3OH + C_6H_6$ mixture | Gms. $H_2O$ to produce clouding per 100 gms. mixture | Gms. $CH_3OH$ per 100 gms. $CH_3OH + C_6H_6$ mixture | Gms. $H_2O$ to produce clouding per 100 gms. mixture |
|---|---|---|---|
| 22.90 | 0.9456 | 48.59 | 3.8000 |
| 32.06 | 1.6624 | 51.22 | 4.1888 |
| 37.80 | 2.2900 | 54.01 | 4.5111 |
| 40.70 | 2.9080 | 57.16 | 5.2640 |
| 45.02 | 3.3721 | 64.23 | 7.1093 |

## Equilibrium in the System Benzene, Methyl Alcohol and Water at 25°.

(Barbaudy, 1926 *a*.)

A diagram of the isotherm of clouding is given and the following results for three pairs of conjugated layers.

| Aqueous Layer. Gms. per 100 gms. sat. sol. | | | | Benzene Layer. Gms. per 100 gms. sat sol. | | | |
|---|---|---|---|---|---|---|---|
| $CH_3OH$. | $C_6H_6$. | $H_2O$. | $d_{\frac{25}{4}}$. | $CH_3OH$. | $C_6H_6$. | $H_2O$. | $d_{\frac{25}{4}}$. |
| 60.8 | 9.8 | 29.4 | 0.8718 | 4.05 | 95.67 | 0.28 | 0.87003 |
| 61.5 | 11.4 | 27.1 | 0.8675 | 4.22 | 95.48 | 0.30 | 0.86978 |
| 61.0 | 10.2 | 28.8 | 0.8700 | 4.09 | 95.63 | 0.28 | 0.8700 |

## Reciprocal Solubility of Methyl Alcohol Benzene and Water at 20°.

(Bancroft, 1895.)

$H_2O$ was added to mixtures of known amounts of $CH_3OH$ + $C_6H_6$ until clouding occurred.

| Per 5 cc $CH_3OH$ | | Per 5 cc $CH_3OH$ | |
|---|---|---|---|
| cc $H_2O$ | cc $C_6H_6$ | cc $H_2O$ | cc $C_6H_6$ |
| 5.0 | 0.15 | 1.0 | 1.9 |
| 3.0 | 0.215 | 0.8 | 3.0 |
| 2.0 | 0.59 | 0.69 | 4.0 |
| 1.4 | 1.00 | 0.49 | 8.0 |

## Reciprocal Solubility of Methyl Alcohol, Benzene and Water.

(Sata and Niwase, 1937.)

The temperatures were determined at which the mixtures of weighed amounts of the three constituents were homogeneous, opalescent or cloudy.

| Gms. per 100 gms. mixture | | | Temperature of: | | |
|---|---|---|---|---|---|
| $CH_3OH$ | $C_6H_6$ | $H_2O$ | Homogeneity | Opalescence | Cloudiness |
| 72.4 | 25.3 | 2.3 | 27.0 | 26.0-23.5 | 23.0 |
| 72.3 | 25.2 | 2.5 | 29.0 | 28.1-27.0 | 26.0 |
| 72.0 | 25.1 | 2.9 | — | — | 30.0 |
| 64.45 | 32.25 | 3.30 | 24.0 | 23.0-21.1 | 19.0 |
| 64.44 | 32.21 | 3.35 | 28.0 | 27.5-24.5 | 23.5 |
| 64.36 | 32.17 | 3.47 | 33.0 | 32.0-26.5 | 24.0 |
| 64.28 | 32.13 | 3.59 | 36.0 | 35.0-29.0 | 28.0 |
| 64.19 | 32.09 | 3.72 | 37.0 | 36.5-32.0 | 31.0 |
| 64.10 | 32.00 | 3.90 | — | — — — | 30.0 |
| 57.40 | 38.20 | 4.40 | 31.0 | 30.0-26.5 | 25.5 |
| 57.30 | 38.10 | 4.60 | 26.0 | 24.8-22.8 | 22.0 |
| 57.20 | 38.10 | 4.70 | — | — — | 30.0 |
| 47.00 | 46.90 | 6.10 | 28.0 | 27.0-26.0 | 25.0 |
| 46.90 | 46.80 | 6.30 | 32.0 | 31.0-30.0 | 29.0 |
| 46.80 | 46.70 | 6.50 | — | — | 30.0 |

The above results at 30° fall close to the curve for the system $C_2H_5OH$ + $C_6H_6$ + $H_2O$ at 30°.

MISCIBILITY OF METHYL ALCOHOL (see Note, p.45 ) AT 0° WITH MIXTURES of:

Brombenzene and Water. (Bonner, 1910.)

| Composition of Homogeneous Mixtures. | | | |
|---|---|---|---|
| Gms. $C_6H_5Br$. | Gms. $H_2O$. | Gms. $CH_3OH$. | Sp. Gr. of Mixture. |
| 0.991 | 0.009 | 0.230 | ... |
| 0.985 | 0.015 | 0.314 | 1.24 |
| *0.98 | 0.02 | 0.40 | ... |
| 0.90 | 0.10 | 1.01 | 1.04 |
| 0.80 | 0.20 | 1.50 | 0.98 |
| 0.70 | 0.30 | 1.84 | 0.95 |
| 0.60 | 0.40 | 2.065 | 0.94 |
| 0.50 | 0.50 | 2.24 | 0.91 |
| 0.40 | 0.60 | 2.30 | 0.90 |
| 0.30 | 0.70 | 2.28 | 0.89 |
| 0.20 | 0.80 | 2.20 | 0.89 |
| 0.095 | 0.905 | 1.927 | 0.90 |
| 0.016 | 0.984 | 1.332 | 0.91 |

Ethyl Bromide and Water. (Bonner, 1910.)

| Composition of Homogeneous Mixtures. | | | |
|---|---|---|---|
| Gms. $C_2H_5Br$. | Gms. $H_2O$. | Gms. $CH_3OH$. | Sp. Gr. of Mixture. |
| 0.973 | 0.027 | 0.202 | 1.27 |
| 0.950 | 0.05 | 0.33 | ... |
| 0.936 | 0.064 | 0.393 | 1.18 |
| 0.90 | 0.10 | 0.54 | 1.14 |
| 0.80 | 0.20 | 0.86 | 1.05 |
| 0.70 | 0.30 | 1.04 | 1.01 |
| 0.60 | 0.40 | 1.18 | 0.99 |
| 0.50 | 0.50 | 1.26 | 0.97 |
| 0.40 | 0.60 | 1.31 | 0.96 |
| 0.20 | 0.80 | 1.21 | 0.94 |
| 0.10 | 0.90 | 0.94 | 0.94 |
| 0.022 | 0.978 | 1.94 | 0.98 |

MISCIBILITY OF METHYL ALCOHOL (see Note, p.45 ) AT 0° WITH MIXTURES OF:

Hexane and Water. (Bonner, 1910.)

| Composition of Homogeneous Mixtures. | | | |
|---|---|---|---|
| Gms. Hexane(1). | Gms. $H_2O$. | Gms. $CH_3OH$. | Sp. Gr. of Mixture. |
| 0.973 | 0.067 | 4.280 | ... |
| 0.90 | 0.10 | 4.69 | 0.80 |
| 0.80 | 0.20 | 5.26 | 0.80 |
| 0.691 | 0.309 | 5.710 | 0.82 |
| 0.60 | 0.40 | 6.17 | 0.81 |
| 0.491 | 0.509 | 6.365 | 0.83 |
| 0.40 | 0.60 | 6.33 | 0.83 |
| 0.30 | 0.70 | 6.13 | 0.84 |
| 0.20 | 0.80 | 5.49 | 0.85 |
| 0.10 | 0.90 | 4.01 | 0.86 |
| 0.016 | 0.984 | 1.759 | 0.91 |

Heptane and Water. (Bonner, 1910.)

| Composition of Homogeneous Mixtures. | | | |
|---|---|---|---|
| Gms. Heptane(1). | Gms. $H_2O$. | Gms. $CH_3OH$. | Sp. Gr. of Mixture. |
| 0.966 | 0.034 | 4.78 | ... |
| 0.90 | 0.10 | 5.55 | 0.80 |
| 0.793 | 0.207 | 6.36 | 0.82 |
| 0.70 | 0.30 | 7.30 | 0.82 |
| 0.60 | 0.40 | 8.22 | 0.82 |
| 0.50 | 0.50 | 8.76 | 0.82 |
| 0.40 | 0.60 | 8.65 | 0.83 |
| 0.30 | 0.70 | 7.78 | 0.83 |
| 0.198 | 0.802 | 6.71 | 0.84 |
| 0.10 | 0.90 | 4.40 | 0.87 |
| 0.038 | 0.962 | 2.96 | 0.91 |

(1) The hexane and heptane used were Kahlbaum's "aus Petroleum."

100 cc. cotton seed oil ($d_{25}$=0.922) dissolve 4.84 gms. $CH_3OH$ at 25°. (Wroth and Reid, 1916.)

100 cc. methyl alcohol dissolve 6.74 gms. cotton seed oil at 25°. " "

DISTRIBUTION OF METHYL ALCOHOL BETWEEN WATER AND COTTON SEED OIL AT 25° (Wroth and Reid, 1916.)

| Gms. $CH_3OH$ per 100 cc. | | Ratio. | Gms. $CH_3OH$ per 100 cc. | | Ratio. |
|---|---|---|---|---|---|
| Oil Layer. | $H_2O$ Layer. | | Oil Layer. | $H_2O$ Layer. | |
| 0.199 | 17.28 | 86.6 | 0.275 | 23.48 | 85.2 |
| 0.253 | 23.34 | 92.2 | 0.258 | 24.44 | 94 |
| 0.298 | 25.73 | 86.2 | 0.284 | 23.06 | 81.4 |
| 0.264 | 24.15 | 91.3 | | | |

Determinations of the Reciprocal Solubility in the systems:

Methyl Alcohol + o Nitrophenol + Water

and " " + p " + " at 25° and at 40°.

are given by Duff, 1929. The systems yield immiscible layers over the lower concentrations of $CH_3OH$ and $C_6H_5NO_2$.

$C_1H_4O_1$

## METHYL ALCOHOL

### Reciprocal Solubility of Methyl Alcohol, Normal Butyl Alcohol and Water.

(Mueller, Pugsley and Ferguson, 1931.)

The binodal curves, tie lines and plait points were determined at temperatures between 0° and 105°. Both the titration method and observation of the temperature of changes in mixtures contained in sealed tubes were used. The compositions are given on the weight basis. The plait points were found by plotting and were also controlled experimentally. The sources of error and methods of overcoming them are described

| Gms. per 100 gms. upper layer | | | Gms. per 100 gms. lower layer | | | |
|---|---|---|---|---|---|---|
| $CH_3OH$ | $H_2O$ | $CH_3(CH_2)_2CH_2OH$ | $CH_3OH$ | $H_2O$ | $CH_3(CH_2)_2CH_2OH$ | |
| | | Results at 0° | | | | |
| 4.20 | 23.30 | 76.70 | 7.0 | 90.0 | 10.0 | |
| 8.75 | 30.10 | 79.90 | 12.50 | 87.50 | 12.5 | |
| 12.25 | 36.90 | 63.10 | 15.50 | 84.80 | 15.20 | |
| 14.50 | 44.25 | 57.20 | 18.90 | 79.50 | 20.50 | |
| 16.50 | 51.50 | 48.50 | 19.40 | 74.50 | 26.50 | |
| 18.50 | 63.10 | 36.90 | 18.50 | 63.10 | 36.90 | PP |
| | | Results at 15° | | | | |
| 2.3 | 21.7 | 78.3 | 4.8 | 91.6 | 8.4 | |
| 4.3 | 24.0 | 76.0 | 8.4 | 90.7 | 9.3 | |
| 6.7 | 27.5 | 72.5 | 10.7 | 89.7 | 10.3 | |
| 9.3 | 32.4 | 67.6 | 13.2 | 88.0 | 12.0 | |
| 12.7 | 40.5 | 59.5 | 15.6 | 83.9 | 16.1 | |
| 14.4 | 47.8 | 52.2 | 16.3 | 80.0 | 20.0 | |
| 16.0 | 64.5 | 35.5 | 16.0 | 64.5 | 35.5 | PP |
| | | Results at 30° | | | | |
| 2.4 | 23.8 | 76.2 | 4.7 | 92.4 | 7.6 | |
| 5.3 | 28.4 | 71.6 | 9.1 | 90.7 | 9.3 | |
| 7.5 | 33.0 | 67.0 | 11.2 | 88.8 | 11.2 | |
| 8.5 | 35.9 | 64.1 | 12.5 | 86.7 | 13.3 | |
| 10.0 | 41.5 | 58.5 | 13.5 | 83.8 | 16.2 | |
| 12.3 | 52.2 | 47.8 | 14.2 | 77.2 | 22.8 | |
| 13.9 | 65.5 | 34.5 | 13.9 | 65.5 | 34.5 | PP |
| | | Results at 45° | | | | |
| 11.5 | 66.0 | 34.0 | 11.5 | 66.0 | 34.0 | PP |
| | | Results at 60° | | | | |
| 9.71 | 66.4 | 33.2 | 9.71 | 66.4 | 33.2 | PP |
| | | Results at 75° | | | | |
| 2.1 | 30.0 | 70.0 | 3.1 | 92.0 | 8.0 | |
| 4.5 | 36.8 | 63.2 | 5.5 | 88.7 | 11.3 | |
| 6.0 | 44.8 | 55.2 | 6.8 | 85.0 | 15.0 | |
| 7.8 | 67.0 | 33.0 | 7.8 | 67.0 | 33.0 | PP |
| | | Results at 90° | | | | |
| 5.0 | 67.3 | 32.7 | 5.6 | 67.3 | 32.7 | PP |
| | | Results at 105° | | | | |
| 3.5 | 67.4 | 32.6 | 3.5 | 67.4 | 32.6 | PP |

Additional results for the binodal curves and upper and lower layers at 45°, 60°, 90° and 105° are given.

## Equilibrium in the System Methyl Alcohol, Iso Butyl Alcohol and Water.

(Jänecke, 1933.)

Weighed amounts of the three constituents were sealed in tubes and the temperatures determined at which clouding and clearing occurred.

| Wt. % $CH_3OH$ in $CH_3OH + H_2O$ Mixture (A) | Gms. $C_4H_{10}O$ per 100 gms. mixture of $C_4H_{10}O$ + (A) | Temp. of: Clouding | Clearing | Wt. % $CH_3OH$ in $CH_3OH + H_2O$ Mixture (A) | Gms. $C_4H_{10}O$ per 100 gms. mixture of $C_4H_{10}O$ + (A) | Temp. of: Clouding | Clearing |
|---|---|---|---|---|---|---|---|
| 0=$H_2O$ | 81.7 | 38.4 | 38.9 | 9.7 | 20.0 | 73.6 | 74.3 |
| " | 57.8 | 126.5 | 126.4 | " | 18.95 | 72.6 | 73.2 |
| " | 49.1 | 132.4 | 132.8 | " | 12.76 | 55.2 | 55.5 |
| " | 26.7 | 133.0 | 133.0 | 16.1 | 74.99 | 25.3 | 27.2 |
| " | 20.7 | 130.3 | 130.6 | " | 56.83 | 68.3 | 68.5 |
| " | 17.5 | 127.6 | 127.7 | " | 52.73 | 69.9 | 70.0 |
| " | 16.3 | 126.7 | 126.7 | " | 22.66 | 37.2 | 37.3 |
| " | 10.6 | 107.7 | 108.0 | " | 17.66 | 17.6 | — |
| " | 8.0 | 90.4 | 90.4 | 20.2 | 76.18 | 2.4 | — |
| 5.2 | 52.07 | 112.6 | 113.0 | " | 69.42 | 33.5 | 33.6 |
| " | 72.42 | 80.8 | 80.9 | " | 52.96 | 49.2 | 49.4 |
| " | 24.33 | 107.2 | 107.3 | " | 38.79 | 32.0 | 32.4 |
| " | 12.93 | 88.1 | 88.2 | " | 29.85 | 23.7 | 23,9 |
| " | 10.63 | 75.6 | 75.8 | " | 23.91 | 10.5 | — |
| 9.7 | 81.06 | 6.8 | 7.5 | 25.0 | 88.6 | 18.3 | 19.7 |
| " | 74.58 | 52.8 | 53.2 | " | 62.74 | 20.5 | — |
| " | 65.13 | 83.7 | 83.9 | " | 50.21 | 21.9 | — |
| " | 61.89 | 86.4 | 88.9 | " | 49.78 | 17.7 | — |
| " | 50.54 | 93.6 | 94.0 | " | 41.32 | 48.32 | — |
| " | 36.04 | 88.1 | 88.4 | " | 28.44 | 22.2 | — |

The author also gives b. pt. determinations, vapor pressures and refractive indices of various binary mixtures of the above compounds.

## Reciprocal Solubility of Methyl Alcohol, Toluene and Water at 25°.

(Mason and Washburn, 1937.)

The binodal curve of this system was determined by adding $H_2O$ to its saturation point to a series of solutions of $CH_3OH$ + $C_6H_5CH_3$ at 25°.

| Gms. per 100 gms. sat. sol. $CH_3OH$ | $C_6H_5CH_3$ | $H_2O$ | Gms. per 100 gms. sat. sol. $CH_3OH$ | $C_6H_5CH_3$ | $H_2O$ |
|---|---|---|---|---|---|
| 8.32 | 91.28 | 0.40 | 65.73 | 7.20 | 27.06 |
| 13.02 | 86.24 | 0.74 | 59.40 | 2.83 | 37.77 |
| 26.22 | 72.40 | 1.37 | 53.12 | 1.37 | 45.50 |
| 36.84 | 60.37 | 2.79 | 41.06 | 0.50 | 58.43 |
| 50.56 | 43.94 | 5.51 | 24.00 | 0.14 | 75.87 |
| 62.15 | 26.99 | 10.86 | 6.72 | 0.06 | 93.23 |
| 67.35 | 14.72 | 17.91 | | | |

The authors also give the refractive indices of the above mixtures and of conjugate solutions as well as results for the distribution of $CH_3OH$ between the liquid layers.

## METHYL ALCOHOL

### Reciprocal Solubility of Methyl Alcohol, Ortho Cresol and Water.
(v. Szelenyi, 1929.)

Weighed amounts of the three compounds were sealed in tubes and the temperatures determined at which the mixtures cleared or clouded. These results were plotted and from the curves, the following points on the binodal curves of the system were obtained.

| Gms. per 100 gms. sat. solution | | |
|---|---|---|
| $CH_3OH$ | o $C_6H_5CH_3OH$ | $H_2O$ |
| **Results at 45°** | | |
| 14.46 | 5.5 | 80.04 |
| 17.35 | 6.75 | 76.90 |
| 20.0 | 25.0 | 55.0 |
| 20.07 | 40.0 | 39.93 |
| 8.86 | 73.5 | 17.64 |
| 5.89 | 78.5 | 15.61 |
| **Results at 55°** | | |
| 14.3 | 6.5 | 79.2 |
| 16.8 | 9.75 | 73.45 |
| 18.84 | 31.3 | 49.86 |
| 17.96 | 46.7 | 35.34 |
| 10.54 | 68.5 | 20.96 |
| 6.17 | 77.5 | 16.23 |
| **Results at 70°** | | |
| 10.92 | 5.8 | 84.0 |
| 13.8 | 9.8 | 76.4 |
| 15.64 | 15.8 | 68.56 |
| 16.23 | 40.8 | 42.97 |
| 7.13 | 74.0 | 18.87 |
| 3.49 | 81.2 | 15.31 |
| 2.72 | 82.2 | 15.08 |
| 0.66 | 85.0 | 14.34 |
| **Results at 95°** | | |
| 4.62 | 5.0 | 90.38 |
| 10.20 | 11.5 | 78.30 |
| 12.23 | 20.0 | 67.77 |
| 13.26 | 34.2 | 52.54 |

| Gms. per 100 gms. sat. solution | | |
|---|---|---|
| $CH_3OH$ | o $C_6H_5CH_3OH$ | $H_2O$ |
| **Results at 95° (Con.)** | | |
| 4.96 | 73.3 | 21.74 |
| 2.13 | 82.5 | 16.37 |
| 0.46 | 81.06 | 17.94 |
| **Results at 120°** | | |
| 0.0 | 5.5 | 94.5 |
| 3.95 | 8.9 | 87.15 |
| 8.27 | 28.2 | 63.53 |
| 7.96 | 48.0 | 44.04 |
| 5.35 | 65.0 | 29.65 |
| 3.34 | 71.0 | 25.66 |
| 1.02 | 76.8 | 22.18 |
| **Results at 140°** | | |
| 0.0 | 7.3 | 92.7 |
| 1.09 | 13.0 | 85.91 |
| 3.63 | 17.0 | 79.37 |
| 1.04 | 68.0 | 30.96 |
| 0.39 | 69.0 | 30.61 |
| 0.0 | 72.0 | 28.0 |
| **Results at 160°** | | |
| 0.0 | 19.5 | 80.5 |
| 0.94 | 24.5 | 74.56 |
| 0.53 | 54.0 | 45.47 |
| 0.0 | 58.5 | 41.5 |
| Crit. Solution Temp. = 169.7° | | |
| 0.0 | 39.5 | 60.5 |

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## Reciprocal Solubility of Methyl Alcohol, Methyl Benzoate and Water.
(Gilbert and Lauer, 1927.)

The determinations were made by the titration method. To a measured volume of one component in a large test tube, maintained at constant temperature, the other components were alternately added from burets, until, upon rapid stirring, the mixture became clear. Calculating from the densities of the liquids the measured volumes were converted to weights.

| $t = 15^\circ$ | | $t = 25^\circ$ | | $t = 35^\circ$ | |
|---|---|---|---|---|---|
| Gms. per 100 gms. mixture | | Gms. per 100 gms. mixture | | Gms. per 100 gms. mixture | |
| $CH_3OH$ | $C_6H_5COOCH_3$ | $CH_3OH$ | $C_6H_5COOCH_3$ | $CH_3OH$ | $C_6H_5COOCH_3$ |
| 0.0 | 99.8 | 0.0 | 99.4 | 0.0 | 98.8 |
| 16.1 | 79.4 | 12.4 | 83.8 | 20.9 | 68.3 |
| 19.4 | 75.0 | 19.2 | 74.1 | 26.9 | 59.9 |
| 29.3 | 60.0 | 31.7 | 54.4 | 32.3 | 51.7 |
| 39.3 | 44.0 | 39.4 | 41.3 | 39.1 | 39.8 |
| 45.1 | 34.5 | 45.4 | 30.0 | 42.7 | 32.7 |
| 47.4 | 29.9 | 49.8 | 17.8 | 44.9 | 28.0 |
| 50.6 | 23.1 | 50.6 | 11.7 | 47.8 | 21.7 |
| 52.6 | 17.3 | 50.3 | 9.5 | 49.2 | 15.2 |
| 52.4 | 14.5 | 46.5 | 4.4 | 48.3 | 11.3 |
| 52.0 | 10.7 | 39.9 | 1.1 | 47.0 | 8.9 |
| 0.0 | 0.1 | 0.0 | 0.4 | 0.0 | 0.5 |

## Reciprocal Solubility of Methyl Alcohol, Cyclohexane and Water at 24.8°.
(Washburn and Spencer, 1934.)

The authors give the following weights of the three components corresponding to points on the binodal curve but do not give the calculated percentage compositions from which their triangular diagram of the system was drawn.

| Composition of the saturated solutions | | |
|---|---|---|
| Gms. $CH_3OH$ | Gms. $C_6H_{12}$ | Gms. $H_2O$ |
| 0.0125 | 2.8555 | 9.8755 |
| 0.0294 | 5.4948 | 9.9300 |
| 0.0555 | 7.7729 | 9.9073 |
| 0.1103 | 7.7508 | 4.9642 |
| 0.3263 | 13.2856 | 4.9529 |
| 0.2760 | 7.0175 | 1.8852 |
| 0.4788 | 8.6026 | 1.8672 |

| Composition of the saturated solutions | | |
|---|---|---|
| Gms. $CH_3OH$ | Gms. $C_6H_{12}$ | Gms. $H_2O$ |
| 0.8520 | 11.1167 | 1.8965 |
| 0.9519 | 8.6042 | 0.9519 |
| 1.4762 | 8.1968 | 0.5204 |
| 1.8943 | 7.8472 | 0.3786 |
| 2.9639 | 7.7553 | 0.1342 |
| 8.7854 | 0.1404 | 0.0397 |
| 7.6861 | 0.0704 | 0.0142 |

The refractive indices of each of the above mixtures were also determined. The authors also give several determinations of the lowering of the freezing-point of methyl alcohol - cyclohexane solutions and the following values for the distribution of methyl alcohol between water and cyclohexane.

| Wt. percent $CH_3OH$ in: | | $\frac{C_1}{C_2}$ | Wt. percent $CH_3OH$ in | | $\frac{C_1}{C_2}$ |
|---|---|---|---|---|---|
| $H_2O$ layer ($C_1$) | $C_6H_{12}$ layer $C_2$ | | $H_2O$ layer ($C_1$) | $C_6H_{12}$ layer $C_2$ | |
| 3.2 | 0.05 | 64 | 34.9 | 0.50 | 70 |
| 15.1 | 0.25 | 60 | 38.8 | 0.65 | 61 |
| 26.8 | 0.40 | 67 | 41.8 | 0.70 | 60 |

The limit of the reciprocal solubility of Methyl Alcohol and Cyclohexane is at 62.8 percent $C_6H_{12}$ and 47.2°. (Lecat, 1930.)

## METHYL ALCOHOL

### Reciprocal Solubility of Methyl Alcohol and Benzene.
(Wieth, 1929.)

| t° | Gms. $C_6H_6$ per 100 gms. mixture | t° | Gms. $C_6H_6$ per 100 gms. mixture |
|---|---|---|---|
| -6.8 | 23.1 | -0.6 | 42.8 |
| -3.8 | 30.1 | +2.0 | 59.7 |
| -1.6 | 37.9 | 2.3 | 62.9 |

### Reciprocal Solubility of Methyl Alcohol and n Hexane.
(Rothmund, 1898.)

The determinations were made by the synthetic method which consists in observing the temperatures at which weighed mixtures of the two liquids become homogenous on slow warming, and become cloudy on slow cooling.

| t° | Gms. $C_6H_{14}$ per 100 gms. | | t° | Gms. $C_6H_{14}$ per 100 gms. | |
|---|---|---|---|---|---|
| | $CH_3OH$ rich layer | $H_2O$ rich layer | | $CH_3OH$ rich layer | $H_2O$ rich layer |
| 10 | 26.5 | 96.8 | 43 | 43.6 | 91.2 |
| 20 | 31.6 | 95.9 | 40 | 52.7 | 85.5 |
| 30 | 38.3 | 93.7 | 42.6 (c.s.t.) | 68.9 | |

Additional results are given by Perschke, 1926, and Howard and Patterson, 1926.

Results for composition of the co-existent liquid and vapor phases in the system methyl alcohol + n hexane at 45° are given by Ferguson, 1932.

### Critical Solution Temperatures of Mixtures of Methyl Alcohol and Other Solvents.
(Cornish, Archibald, Murphy and Evans, 1934.)

| Mixture | | c.s.t. |
|---|---|---|
| $CH_3OH$ + $C_2Cl_4$ | (Tetra chlor ethylene) | 10.0 |
| " + $CH_3(CH_2)_3CH_3$ | (n Pentane) | 14.75 |
| " + $CH_3(CH_2)_4CH_3$ | (n Hexane) | 32.0 |
| " + " | " | 34.0 (Freed, 1933.) |
| " + $CH_3(CH_2)_5CH_3$ | (n Heptane) | 51.5 |
| " + $C_8H_{18}$ | (i-Octane = 2.2.4-Tri methyl Pentane) | 42.5 |

A diagram of the results showing the depression of the critical solution temperature (33.6°) of mixtures of Methyl Alcohol and Hexane, produced by increasing amounts of $C_5H_{11}COOH$, $C_6H_{13}COOH$, $C_7H_{15}COOH$ and $C_8H_9COOH$, is given by Ssementschenko, W. and Davidoffokaja, E., 1934.

Determinations of the Reciprocal Solubility of Methyl Alcohol and Tetra Ethyl Silan, $Si(C_2H_5)_4$, are given by Bjerrum and Jozefowitz, 1932.)

## Reciprocal Solubility of Methyl Alcohol and Cyclohexane.
(Jones and Anstell, 1930.)

The synthetic method was used and special care observed in purifying the $CH_3OH$ and $C_6H_{12}$ and in preventing entrance of $H_2O$ while weighing the liquids in the glass tubes which were afterwards sealed for observing the solubility limits.

| t° | Gms. $C_6H_{12}$ per 100 gms. mixture | t° | Gms. $C_6H_{12}$ per 100 gms. mixture | t° | Gms. $C_6H_{12}$ per 100 gms. mixture |
|---|---|---|---|---|---|
| 17.1 | 33.23 | 45.56 | 69.86 | 45.10 | 81.25 |
| 30.4 | 39.40 | 45.58 | 70.80 | 42.80 | 86.93 |
| 40.05 | 48.96 | 45.60* | 72.00 | 37.5 | 91.47 |
| 42.68 | 53.60 | 45.58 | 72.81 | 32.3 | 93.40 |
| 44.62 | 59.49 | 45.53 | 77.60 | 30.6 | 95.50 |
| 45.45 | 66.18 | 45.45 | 79.26 | 6.1 | 97.30 |
| 45.52 | 69.15 | 45.32 | 80.64 | | |

* Critical solution temperature

The authors also determined the reciprocal solubility curves in mixtures made with $CH_3OH$ containing small amounts of $H_2O$. The results show that the maximum critical point is increased more than the ternary critical solution point by given amounts of $H_2O$. In order to use this procedure for determining traces of $H_2O$ in $CH_3OH$, the weight concentration of 75 percent $C_6H_{12}$ was selected and the following changes in maximum critical point with increasing amounts of $H_2O$ were found.

| | | | | | | |
|---|---|---|---|---|---|---|
| Wt. % $H_2O$ in $CH_3OH$ | 0.0 | 0.331 | 0.800 | 1.114 | 2.031 | 3.900 |
| Max. crit. temp. of 75 wt. % $C_6H_{12}$ mixtures | 45.55° | 50.52° | 55.74° | 58.75° | 66.50° | 81.56° |

The authors give similar results showing the effect of benzene and acetone admixtures upon the maximum critical temperatures of the system.

## Freezing-points of Mixtures of Methyl Alcohol and:
(Saphir, 1929.)

| Ethyl Alcohol, $C_2H_5OH$ | | Acetone, $(CH_3)_2CO$ | | Ethyl Ether, $(C_2H_5)_2O$ | |
|---|---|---|---|---|---|
| t° | Wt. % $CH_3OH$ in Mixture | t° | Wt. % $CH_3OH$ in Mixture | t° | Wt. % $CH_3OH$ in Mixture |
| - 97.8 | 100 | -103.0 | 84.1 | -106.3 | 82.0 |
| -103.1 | 91.7 | -108.7 | 71.2 | -113.4 | 62.8 |
| -111.8 | 80.0 | -111.7 | 59.2 | -117.4 | 50.1 |
| -120.9 | 71.4 | -115.7 (Eutec) | 50.3 (?) | -121.2 | 31.1 |
| -150 (Eutec) | (Esti.) | -113.7 | 36.1 | -119.5 (Eutec) | |
| -129.6 | 16.9 | -111.0 | 27.7 | -126.0 (Eutec) | (unstable) |
| -122.5 | 10.2 | -108.3 | 27.5 | -119.0 | 15.4 |
| -114.0 | 0.0 | -104.1 | 13.3 | -118.9 | 10.1 |
| | | - 95.6 | 0.0 | -118.0 | 6.2 |
| | | | | -116.4 | 0.0 |

The methyl alcohol branch of the $CH_3OH$ + $(CH_3)_2CO$ system shows an angle at -112.2° corresponding probably to the polymorphic transformation of $CH_3OH$ reported by Parks, 1925.

FREEZING-POINTS OF MIXTURES OF BENZENE AND METHYL ALCOHOL. (Porrakis, 1925.)

| t° of cryst. | Mols. $C_6H_6$ per 100 mols. of Mixture. | t° of cryst. | Mols. $C_6H_6$ per 100 mols. of Mixture. | t° of cryst. | Mols. $C_6H_6$ per 100 mols. of Mixture. |
|---|---|---|---|---|---|
| 5.40 | 100.00 | —0.10 | 42.57 | —11.50 | 16.45 |
| 3.25 | 92.16 | —1.35 | 36.67 | —17.00 | 13.67 |
| 3.00 | 84.22 | —3.20 | 31.00 | —23.00 | 9.86 |
| 2.40 | 75.00 | —4.90 | 27.18 | —46.00 | 7.07 |
| 2.10 | 63.08 | —7.60 | 22.98 | —67.0 | 4.93 |
| 1.85 | 57.32 | —9.70 | 19.39 | —94.0 | 0.00 |
| 1.40 | 49.39 | | | | |

The author also gives tables and curves for benzene and normal butyl alcohol and for benzene and iso-propyl alcohol.

Freezing-point data are given for:

| | |
|---|---|
| $CH_3OH$ + $CHCl_3$ | (Baume and Borowski, 1914, Saphir, 1929; Wyatt, 1929.) |
| " + $CH_3Cl$ | (Baume, 1914.) |
| " + $CH_3I$ | (Baume and Tykociner, 1914.) |
| " + $CH_3COOH$ | (Pickering, 1893.) |
| " + $HCONH_2$ | (Joukovsky, 1934.) |
| " + $C_2H_5COOH$ | (Baume and Pamfil, 1914.) |
| " + $C_2H_5COOH \cdot HCl$ | " " " |
| " + $C_6H_6$ | (Pickering, 1893.) |
| " + $NH_3$ | (Baume and Borowski, 1914.) |
| " + $SO_2$ | (Baume and Pamfil, 1914.) |
| $CH_3OH.HCl$ + $C_2H_5COOH$ | (Baume, 1914.) |

**UREA** (Carbamide) $CO(NH_2)_2$.

SOLUBILITY OF UREA IN WATER.

The closely agreeing results of Pinck and Kelly, 1925; Jänecke and Rahlf, 1930; Schnidman and Sunier, 1932; Miller and Dittmar, 1934; and Wetrow, 1937, were plotted, and the following values taken from the smooth curve. In most cases the determinations were made by the synthetic method and in others by direct analysis of the saturated solutions using the urease method for urea. The earlier results of Speyers, 1902, are somewhat too low.

Very careful determinations of the freezing-point lowering in aqueous solutions of urea are given by Chadwell and Politi, 1938.

| t° | Gms. $CO(NH_2)_2$ per 100 gms. sat. sol. | Solid Phase | t° | Gms. $CO(NH_2)_2$ per 100 gms. sat. sol. | Solid Phase |
|---|---|---|---|---|---|
| - 5 | 15.0 | Ice | 40 | 62.5 | $CO(NH_2)_2$ |
| - 7.5 | 21.2 | " | 50 | 67.0 | " |
| -10 | 27.0 | " | 60 | 71.5 | " |
| -11.5 (Eutec) | 32.5 | " + $CO(NH_2)_2$ | 70 | 75.6 | " |
| 0 | 40.0 | $CO(NH_2)_2$ | 80 | 80.0 | " |
| +10 | 46.0 | " | 90 | 84.0 | " |
| 20 | 52.0 | " | 100 | 88.0 | " |
| 25 | 54.8 | " | 120 | 95.5 | " |
| 30 | 57.5 | " | 132.6 | 100.0 | " |

10 cc cold sat. aqueous solution of Magnesium PerChlorate ($Mg(ClO_4)_2$) dissolve more than 11 gms. of $CO(NH_2)_2$. (Duclaux and Durand-Gasselin, 1938.)

## Solubility of Urea in Aqueous Solutions of Nitric Acid.

(Dalman, 1934.)

The saturated solutions were prepared by agitation at constant temperatures and weighed portions analyzed for acid by titration and for urea by the urease method as described by Fox and Gelhard, 1923.

| Results at 10° | | Results at 25° | | Results at 40° | | Solid Phase |
|---|---|---|---|---|---|---|
| Gms. per 100 gms. sat. sol. | | Gms. per 100 gms. sat. sol. | | Gms. per 100 gms. sat. sol. | | at each Temp. |
| $HNO_3$ | $CO(NH_2)_2$ | $HNO_3$ | $CO(NH_2)_2$ | $HNO_3$ | $CO(NH_2)_2$ | |
| 0.0 | 46.0 | 0.0 | 54.5 | 0.0 | 62.3 | $CO(NH_2)_2$ |
| 2.2 | 48.1 | 3.2 | 56.8 | 5.8 | 64.9 | " |
| 6.5 | 52.5 | 9.7 | 61.6 | 11.0 | 67.0 | " |
| 9.0 | 54.7 | 12.1 | 63.1 | 14.7 | 68.3 | "+$CO(NH_2)_2.HNO_3$ |
| 8.1 | 44.7 | 11.2 | 50.0 | 14.3 | 55.6 | $CO(NH_2)_2.HNO_3$ |
| 6.8 | 28.4 | 9.4 | 27.1 | 13.9 | 38.9 | " |
| 5.8 | 11.7 | 9.1 | 11.1 | 12.5 | 19.5 | " |
| 8.5 | 3.2 | 13.5 | 2.4 | 14.3 | 8.9 | " |
| 17.0 | 1.1 | 31.2 | 1.3 | 25.5 | 3.1 | " |
| 33.0 | 0.5 | 49.9 | 1.4 | 40.8 | 1.8 | " |
| 50.0 | 0.4 | 66.1 | 1.7 | 55.1 | 2.1 | " |
| 67.2 | 0.4 | | | 65.3 | 2.4 | " |

## Solubility of Urea in Aqueous Solutions of Sulfuric Acid.

(Dalman, 1934.)

| Results at 10° | | | Results at 25° | | |
|---|---|---|---|---|---|
| Gms. per 100 gms. sat. sol. | | Solid Phase | Gms. per 100 gms. sat. sol. | | Solid Phase |
| $H_2SO_4$ | $CO(NH_2)_2$ | | $H_2SO_4$ | $CO(NH_2)_2$ | |
| 0.0 | 46.0 | $CO(NH_2)_2$ | 0.0 | 54.5 | $CO(NH_2)_2$ |
| 3.2 | 48.6 | " | 9.6 | 59.2 | " |
| 11.9 | 54.2 | " | 19.3 | 62.4 | " |
| 18.0 | 57.2 | " | 29.3 | 65.8 | "+$[CO(NH_2)_2]_2H_2SO_4$ |
| 28.2 | 62.2 | "+$[CO(NH_2)_2]_2.H_2SO_4$ | 31.0 | 60.6 | $[CO(NH_2)_2]_2.H_2SO_4$ |
| 30.1 | 56.0 | $[CO(NH_2)_2]_2.H_2SO_4$ | 35.7 | 49.2 | " |
| 37.2 | 40.4 | " | 39.0 | 44.1 | " |
| 44.9 | 36.8 | " | 46.4 | 40.3 | " |
| 51.6 | 38.0 | "+$CO(NH_2)_2.H_2SO_4$ | 52.7 | 42.2 | "+$CO(NH_2)_2.H_2SO_4$ |
| 52.4 | 34.2 | $CO(NH_2)_2.H_2SO_4$ | 53.2 | 39.4 | $CO(NH_2)_2.H_2SO_4$ |
| 56.0 | 22.0 | " | 57.9 | 25.0 | " |
| 68.4 | 12.6 | " | 68.9 | 19.3 | " |
| 74.0 | 19.7 | " | 72.1 | 24.3 | " |
| 74.6 | 24.7 | " | 72.9 | 26.5 | " |

$C_1H_4O_1$

## Solubility of Urea in Aqueous Solutions of Oxalic Acid.

(Dalman, 1934.)

| Results at 10° | | Results at 25° | | Results at 40° | | Solid Phase |
|---|---|---|---|---|---|---|
| Gms. per 100 gms. sat. sol. | | Gms. per 100 gms. sat. sol. | | Gms. per 100 gms. sat. sol. | | at each |
| $H_2C_2O_4$ | $CO(NH_2)_2$ | $H_2C_2O_4$ | $CO(NH_2)_2$ | $H_2C_2O_4$ | $CO(NH_2)_2$ | Temp. |
| 0.0 | 46.0 | 0.0 | 54.5 | 0.0 | 62.3 | $CO(NH_2)_2$ |
| 0.2 | 46.2 | 0.3 | 54.6 | 0.5 | 62.4 | "+$[CO(NH_2)_2]_2.H_2C_2O_4$ |
| 0.2 | 43.3 | 0.3 | 47.9 | 0.5 | 55.0 | $[CO(NH_2)_2]_2.H_2C_2O_4$ |
| 0.2 | 32.2 | 0.3 | 35.0 | 0.6 | 32.4 | " |
| 0.2 | 15.6 | 0.6 | 26.9 | 0.9 | 16.1 | " |
| 0.4 | 4.6 | 0.9 | 9.4 | 2.2 | 6.6 | " |
| 2.3 | 1.2 | 5.0 | 1.9 | 5.8 | 3.9 | " |
| — | — | 10.3 | 1.5 | 14.7 | 2.8 | "+$CO(NH_2)_2.H_2C_2O_4$ |
| — | — | — | — | 16.9 | 2.5 | $CO(NH_2)_2.H_2C_2O_4$ |
| 5.7 | 0.9 | 11.0 | 1.4 | 19.3 | 2.2 | "+$H_2C_2O_4.2\ H_2O$ |
| — | — | — | — | 18.7 | 1.2 | $H_2C_2O_4.2H_2O$ |
| 5.4 | 0.0 | 10.2 | 0.0 | 17.8 | 0.0 | " |

## Solubility of Urea in Aqueous Solutions of Acetic Acid.

(Dalman, 1937.)

In the case of this system the urease method for urea gave incorrect results in presence of acetic acid and the determinations were made by removing this acid by evaporation to dryness at 50-60° and weighing the residue of dried urea.

| Results at 10° | | Results at 25° | | Results at 40° | | Solid Phase |
|---|---|---|---|---|---|---|
| Gms. per 100 gms. sat. sol. | | Gms. per 100 gms. sat. sol. | | Gms. per 100 gms. sat. sol. | | at each |
| $CH_3COOH$ | $CO(NH_2)_2$ | $CH_3COOH$ | $CO(NH_2)_2$ | $CH_3COOH$ | $CO(NH_2)_2$ | Temp. |
| 0.0 | 46.0 | 0.0 | 54.5 | 0.0 | 62.3 | $CO(NH_2)_2$ |
| 7.3 | 45.9 | 10.4 | 52.7 | 10.2 | 59.6 | " |
| 14.4 | 45.5 | 19.8 | 50.8 | 20.1 | 56.6 | " |
| 21.8 | 44.8 | 30.7 | 48.0 | 40.9 | 49.0 | " |
| 29.3 | 43.6 | 41.5 | 45.3 | 51.8 | 44.8 | " |
| 40.7 | 41.7 | 50.2 | 42.6 | — | — | "+$CO(NH_2)_2.2CH_3COOH$ |
| 44.0 | 36.4 | 54.4 | 37.0 | 60.6 | 39.3 | $CO(NH_2)_2.2CH_3COOH$ |
| 52.9 | 25.8 | 59.9 | 30.5 | 62.7 | 37.0 | " |
| 64.7 | 17.2 | 69.3 | 22.8 | 64.2 | 35.5 | " |
| 75.6 | 12.3 | 74.4 | 17.1 | 66.3 | 33.2 | " |
| 86.0 | 8.5 | 88.5 | 11.2 | 69.9 | 29.7 | " |
| 90.5 | 7.0 | — | — | 72.8 | 27.0 | " |
| 91.8 | 6.5 | — | — | — | — | "+$CH_3COOH$ |
| 94.1 | 2.5 | — | — | — | — | $CH_3COOH$ |
| 95.6 | 4.4 | — | — | — | — | " |

## Solubility of Urea in Aqueous Solutions of Tartaric Acid.

(Dalman, 1937.)

Results at 10°

| Gms. per 100 gms. sat. sol. $H_2C_4H_4O_6$ | Gms. per 100 gms. sat. sol. $CO(NH_2)_2$ | Solid Phase |
|---|---|---|
| 8.4 | 46.0 | $CO(NH_2)_2$ |
| 15.8 | 46.0 | " |
| 24.3 | 46.0 | " |
| 32.8 | 46.0 | " + 2.1 |
| 36.1 | 40.6 | 2.1 |
| 40.0 | 35.8 | " |
| 43.4 | 32.3 | " |
| 46.2 | 30.0 | " + 1.2 |
| 45.9 | 25.5 | 1.2 |
| 45.9 | 20.3 | " |
| 46.3 | 14.6 | " |
| 48.2 | 9.3 | " |
| 51.7 | 5.1 | " |
| 51.3 | 4.6 | " |
| 55.9 | 4.7 | " + $H_2C_4H_4O_6$ |
| 55.5 | 3.1 | $H_2C_4H_4O_6$ |
| 54.5 | 0.0 | " |

Results at 25°

| Gms. per 100 gms. sat. sol. $H_2C_4H_4O_6$ | Gms. per 100 gms. sat. sol. $CO(NH_2)_2$ | Solid Phase |
|---|---|---|
| 8.7 | 53.2 | $CO(NH_2)_2$ |
| 17.5 | 51.8 | " |
| 27.7 | 50.3 | " |
| 35.9 | 49.0 | " + 2.1 |
| 39.6 | 43.9 | 2.1 |
| 44.4 | 38.0 | " |
| 48.8 | 33.5 | " + 1.2 |
| 49.7 | 25.6 | 1.2 |
| 50.5 | 20.3 | " |
| 51.6 | 14.7 | " |
| 54.6 | 8.4 | " |
| 56.6 | 6.0 | " |
| 59.1 | 5.0 | " + $H_2C_4H_4O_6$ |
| 58.8 | 3.2 | $H_2C_4H_4O_6$ |
| 58.5 | 0.0 | " |

2.1 = $[CO(NH_2)_2]_2.H_2C_4H_4O_6$; 1.2 = $CO(NH_2)_2 \cdot 2(H_2H_4H_4O_6)$.

## Solubility of Urea in Ethyl Acetate containing Small Amounts of Water at 25°.

(Lewis and Burrows, 1912.)

| Gms. $H_2O$ per 100 Gms. Solvent. (Ethyl Acetate + $H_2O$). | Gms. Urea per 100 Gms. Sat. Sol. | Gms. $H_2O$ per 100 Gms. Solvent. (Ethyl Acetate + $H_2O$). | Gms. Urea per 100 Gms. Sat. Sol. |
|---|---|---|---|
| 0 | 0.080 | 1.677 | 0.308 |
| 0.652 | 0.148 | 2.006 | 0.328* |
| 1.112 | 0.198 | 2.138 | 0.342 |
| 1.638 | 0.296 | 3.234 | 0.343† |

* A second liquid phase was suspected here.

† A second liquid phase could be distinguished.

## Solubility of Urea in Acetic Acid Determined by the Freezing-Point Method.

(Wetrow, 1937.)

| t° | Gm. Mols. $CO(NH_2)_2$ per 100 gm. mols. mixture | Solid Phase |
|---|---|---|
| 16.8 | 0.0 | $CH_3COOH$ |
| 15.3 | 3.0 | " |
| 13.0 | 5.0 | " |
| 12.4 | Eutec. — | "+$CO(NH_2)_2 \cdot 2CH_3COOH$ |
| 19.7 | 8.0 | $CO(NH_2)_2 \cdot 2CH_3COOH$ |
| 30.8 | 15.0 | " |
| 39.9 | 25.0 | " |
| 41.5 | 33.3 | " |
| 40.7 | 36.0 | " |
| 39 | Eutec. 42.0 | $CO(NH_2)_2 \cdot 2CH_3COOH + CO(NH_2)_2$ |
| 53 | 46.0 | $CO(NH_2)_2$ |
| 59 | 48 | " |
| 65.5 | 50.0 | " |
| 71.0 | 52.0 | " |
| 76.0 | 54.0 | " |
| 81.5 | 56.0 | " |
| 90.5 | 60.0 | " |
| 92.5 | 65.0 | " |

## Solubility of Urea in Aqueous Solutions of Citric Acid.

(Dalman, 1937.)

| Results at 10° | | Results at 25° | | Results at 40° | | Solid Phase at each Temp. |
|---|---|---|---|---|---|---|
| Gms. per 100 gms. sat. sol. | | Gms. per 100 gms. sat. sol. | | Gms. per 100 gms. sat. sol. | | |
| $H_3C_6H_5O_7$ | $CO(NH_2)_2$ | $H_3C_6H_5O_7$ | $CO(NH_2)_2$ | $H_3C_6H_5O_7$ | $CO(NH_2)_2$ | |
| 2.9 | 45.9 | 5.4 | 53.6 | 6.5 | 60.2 | $CO(NH_2)_2$ |
| 5.2 | 45.9 | 10.5 | 52.5 | 17.7 | 56.6 | " + 4.1 |
| 6.3 | 42.2 | 12.5 | 49.4 | 20.4 | 52.8 | 4.1 |
| 7.8 | 39.0 | 15.0 | 46.2 | 23.7 | 49.7 | " |
| 9.6 | 35.0 | 17.8 | 43.0 | 27.0 | 46.7 | 4.1 + 2.1 |
| 10.4 | 29.5 | 19.3 | 38.0 | 28.7 | 43.2 | 2.1 |
| 12.1 | 24.6 | 21.7 | 32.5 | 30.3 | 40.1 | " |
| 14.3 | 18.8 | 23.8 | 28.2 | 32.1 | 37.0 | " + 1.1 |
| 17.2 | 12.0 | 24.0 | 22.6 | 32.4 | 30.0 | 1.1 |
| 22.4 | 7.2 | 24.4 | 17.6 | 34.1 | 21.7 | " |
| 31.0 | 3.0 | 27.0 | 12.1 | 39.4 | 12.1 | " |
| 42.9 | 1.5 | 34.6 | 6.1 | 48.1 | 5.7 | " |
| 48.7 | 1.2 | 41.6 | 4.0 | 56.0 | 3.0 | " |
| — | — | 51.7 | 2.4 | 64.0 | 2.3 | " |
| 54.0 | 1.0 | 62.2 | 1.4 | 69.0 | 1.8 | " + $H_3C_6H_5O_7$ |
| 54.0 | 0.0 | 62.1 | 0.0 | 68.6 | 0.0 | $H_3C_6H_5O_7$ |

4.1 = $[CO(NH_2)_2]_4.H_3C_6H_5O_7$; 2.1 = $[CO(NH_2)_2]_2.H_3C_6H_5O_7$; 1.1 = $CO(NH_2)_2.H_3C_6H_5O_7$.

Results for the equilibrium in the system Urea, Ammonia and Water, determined by the synthetic and freezing-point methods together with vapor pressures, fixing the range of existence of the solid phases, Urea, ammonium carbonate, bicarbonate, sesquicarbonate and carbamate are given by Jänecke, 1930, and Jänecke and Rahlfs, 1930, 1932.

## Solubility of Urea in Methyl Alcohol. (Walton and Wilson, 1925.)

The saturated solutions were prepared by vigorous stirring at constant temperature. The solutions were analyzed by evaporating and weighing the residue. At the lower temperatures a stable molecular compound, $CO(NH_2)_2.CH_3OH$, is formed.

| t°. | Gms. $CO(NH_2)_2$ per 100 gms. $CH_3OH$. | Solid Phase. |
|---|---|---|
| −15.20. | 10.92 | $CO(NH_2)_2$ (Unstable form) |
| − 9.85. | 11.64 | » |
| + 0.25. | 14.24 | » |
| 7.33. | 16.70 | » |
| 15.23. | 19.73 | » |
| 18.14. | 21.16 | » |
| −78.0.. | 0.32 | $CO(NH_2)_2.CH_3OH$ (Stable form) |
| −24.9 . | 2.89 | » |
| −21.3.. | 3.17 | » |
| −20.2.. | 3.25 | » |
| −18.1.. | 3.48 | » |

| t°. | Gms. $CO(NH_2)_2$ per 100 gms. $CH_3OH$. | Solid Phase. |
|---|---|---|
| −17.45. | 3.76 | $CO(NH_2)_2.CH_3OH$ (Stable form) |
| −17.0.. | 3.63 | » |
| −15.2.. | 3.93 | » |
| − 9.85. | 4.88 | » |
| + 0.25. | 7.71 | » |
| 7.33. | 10.98 | » |
| 8.03. | 11.30 | » |
| 15.23. | 16.47 | » |
| 16.63. | 17.72 | » |
| 18.14. | 19.56 | » |
| 18.79. | 20.27 | » |

The transition point between $CO(NH_2)$ and $CO(NH_2)_2 CH_3OH$ is at + 19°.25

## Solubility of Urea in Alcohols.

(Speyers, 1902)

| t°. | In Methyl Alcohol. Wt. of 1 cc. sat. sol. | In Methyl Alcohol. Gms. $CO(NH_2)_2$ per 100 gms. $CH_3OH$ | In Ethyl alcohol. Wt. of 1 cc. sat. sol. | In Ethyl alcohol. Gms. $CO(NH_2)_2$ per 100 gms. $C_2H_5OH$. |
|---|---|---|---|---|
| 0..... | 0.861 | 15.0 | 0.8213 | 2.6 |
| 10..... | 0.863 | 17.7 | 0.814 | 4.0 |
| 20..... | 0.869 | 22.0 | 0.804 | 5.4 |
| 25..... | 0.872 | 24.5 | 0.805 | 6.2 |
| 30..... | 0.876 | 27.7 | 0.806 | 7.2 |
| 40..... | 0.890 | 35.3 | 0 804 | 9.3 |
| 50..... | 0.908 | 46.0 | 0.803 | 11.7 |
| 60..... | 0 928 | 62.8 | — | 15.1 |
| 70..... | — | — | — | 20.2 |

100 gms. abs. methyl alcohol dissolve 21.8 gms. $CO(NH_2)_2$ at 19.5°.
100 gms. abs. ethyl alcohol dissolve 5.06 gms. $CO(NH_2)_2$ at 19.5°. (de Bruyn, 1903.)

## Solubility of Urea in Alcohols.

(Timofeiew, 1894.)

| Alcohol. | t°. | Gms. $CO(NH_2)_2$ per 100 Gms. Solvent. | Alcohol. | t°. | Gms. $CO(NH_2)_2$ per 100 Gms. Solvent. |
|---|---|---|---|---|---|
| Methyl Alcohol | −12 | 11 | Isopropyl Alcohol | 19.4 | 5.76 |
| " | 0 | 14.2 | " | 20 | 6.17 |
| " | 19 | 20.9 | " | 81 | 23.46 |
| " | 40 | 36.4 | Isobutyl Alcohol | 0 | 1.01 |
| " | 62 | 66.6 | " | 19 | 1.65 |
| " | 71 | 107.4 | " | 41 | 3.12 |
| Ethyl Alcohol | − 9 | 2.69 | " | 60 | 4.40 |
| " | 0 | 3.26 | " | 80 | 6.34 |
| " | 18 | 5 | " | 98 | 10 |
| " | 41 | 9.45 | Isoamyl Alcohol | 20 | 1.18 |
| " | 60 | 16.3 | " | 60 | 3.41 |
| " | 81 | 30.8 | " | 80 | 4.88 |
| Propyl Alcohol | 0 | 1.65 | " | 83 | 5.24 |
| " | 20 | 2.56 | " | 98 | 6.15 |
| " | 40 | 5.12 | Capryl Alcohol | 19.4 | 0.56 |
| " | 60 | 7.72 | " | 98 | 2 |
| " | 80 | 12.28 | Ally Alcohol | 19.4 | 9.37 |
| " | 98 | 18.06 | | | |

## Solubility of Benzoic Acid in Ethyl Alcohol Solutions of Urea at 25° and Vice Versa. (Osaka and Ando, 1921.)

| Gms. per 100 gms. sat. sol. $C_6H_5COOH$. | Gms. per 100 gms. sat. sol. $CO(NH_2)_2$. | Solid Phase. | Gms. per 100 gms. sat. sol. $C_6H_5COOH$. | Gms. per 100 gms. sat. sol. $CO(NH_2)_2$. | Solid Phase. |
|---|---|---|---|---|---|
| 36.92 | 0.00 | $C_6H_5COOH$ | 45.65 | 12.12 | $C_6H_5COOH$ |
| 37.64 | 0.72 | " | 46.23 | 12.51 | $C_6H_5COOH + CO(NH_2)_2$ |
| 38.55 | 1.81 | " | | | |
| 39.38 | 2.64 | " | 43.78 | 12.15 | $CO(NH_2)_2$ |
| 40.75 | 4.22 | " | 35.06 | 12.76 | " |
| 41.56 | 5.10 | " | 25.38 | 9.41 | " |
| 42.31 | 6.11 | " | 11.22 | 7.39 | " |
| 42.90 | 7.09 | " | 5.06 | 6.59 | " |
| 44.68 | 9.67 | " | 0.00 | 5.82 | " |

### Solubility of Urea in Mixtures of Ethyl Alcohol and Quinoline at 20-25°.

(Pucher and Dehn, 1921.)

| Per cent $C_7H_9N$ in solvent. | Gms. $CO(NH_2)_2$ per 100 cc. sat. sol. | Per cent $C_7H_9N$ in solvent. | Gms. $CO(NH_2)_2$ per 100 cc. sat. sol. | Per cent $C_7H_9N$ in solvent. | Gms. $CO(NH_2)_2$ per 100 cc. sat. sol |
|---|---|---|---|---|---|
| 0.0 | 5.0 | 47.5 | 1.50 | 65 | 0.32 |
| 10.0 | 4.0 | 50.0 | 1.05 | 70 | 0.50 |
| 23.2 | 2.5 | 55.0 | 0.64 | 80 | 0.19 |
| 37.5 | 1.8 | 60.0 | 0.26 | 90 | 0.10 |
| | | | | 100 | 0.11 |

### Solubility of Urea in Ethyl Ether.

(Gortner, 1914.)

When 0.3255 gm. urea was extracted in a Soxhlet apparatus with anhydrous ether for 48 hours, the extract was found to contain 0.072 gm. urea. An approximate estimate, based on the volume of liquid and the number of siphonings per hour indicates a solubility of 0.0004 gm. urea per 100 cc. of ether.

100 gms. glycerol dissolve about 50 gms. urea at 15°.

100 gms. pyridine dissolve 0.96 gm. urea at 20–25°. (Dehn, 1917.)

100 gms. aq. 50% pyridine dissolve 21.53 gms. urea at 20–25°.

Results for equilibrium in the system Urea + Di phenyl amine are given by Nijveld, 1934, and for the system Urea + Di phenyl amine + Resorcinol are given by Hyrnakowski, Staszewski and Szmyt, 1937.

### Solubility of Urea in Liquid Ammonia.

(Scholl and Davis, 1934.)

From the volume and pressure of the vapor above the saturated solutions at given temperatures, determined in an isotensiscope, the amount of $NH_3$ was calculated and this subtracted from the weight of liquid ammonia present in the original mixtures, to find the composition of the saturated solutions. Previous determinations of this system by Jänecke, 1930, agree well with the present results.

| t° | Gm. Mols. $CO(NH_2)_2$ per 100 gm. mols. mixture | Gms. $CO(NH_2)_2$ per 100 gms. $NH_3$ | Gms. $CO(NH_2)_2$ per 100 gms. sat. sol. | Vapor Pressure in Atmos. | Solid Phase |
|---|---|---|---|---|---|
| -26.6 | 6.64 | 25.10 | 20.8 | 1.3 | $CO(NH_2)_2.NH_3$ |
| 5.8 | 15.26 | 63.52 | 38.8 | 4.7 | " |
| 23.9 | 23.39 | 107.6 | 51.8 | 7.6 | " |
| 35.9 | 32.29 | 168.2 | 62.8 | 9.2 | " |
| 40.9 | 37.60 | 212.5 | 68.0 | 9.4 | " |
| 44.7 | 43.59 | 272.5 | 73.2 | 9.0 | " |
| 45.6 | tr.pt. — | — | 74.6 | — | " + $CO(NH_2)_2$ |
| 50.0 | 47.20 | 315.2 | 75.9 | 9.4 | $CO(NH_2)_2$ |
| 61.8 | 52.05 | 382.9 | 79.3 | 11.1 | " |
| 81.0 | 61.39 | 560.6 | 84.8 | 13.4 | " |
| 82.0 | 61.53 | 563.9 | 85.0 | 13.5 | " |
| 101.0 | 74.38 | 1024. | 91. | 12.5 | " |

## UREA

Freezing-point data are given for:

Urea ($CO(NH_2)_2$) +

$CCl_3COOH$ (tri chlor acetic acid) (1)(2)
$CHCl_2COOH$ (di chlor acetic acid)(2)
$CH_2ClCOOH$ (mono chlor acetic acid(2)
$CH_3COOH$ (acetic acid)(2)(7)(22)
$CN.NH_2$ (cyanamide)(26)(28)(29)
$(CONH_2)_2NH$ (biuret)(27)
$COOC_2H_5.NH_2$ (urethan)(5)(8)
$(CH_2OHCHOH)_2$ (erythritol)(3)
$C_6H_5OH$ (phenol)(1)(21)(23)(25)
$C_6H_4(OH)_2$ o (pyrocatechol)(2)(30)
$C_6H_4(OH)_2$ m (resorcinol)(1)(10)(30)
$C_6H_4(OH)_2$ p (hydroquinol)(1)
$C_6H_5OHCOOH$ o (salicylic acid(22)
$C_6H_4OHCH_3$ o (cresol)(4)
$C_6H_4OHOCH_3$ (guaicol)(1)(6)
$C_6H_5NO_2$ (nitro benzene)(31)
$C_6H_4(NO_2)_2$ o (di nitrobenzene)(20)
" m " (20)(31)
" p " (20)
$C_6H_3(NO_2)_3$ s (tri nitrobenzene (31)
$C_6H_4OH(NO_2)$ o (nitrophenol)(21)
" m " (21)
" p " (21)
$C_6H_3OH(NO_2)_2$ 1.2.4 (di nitro phenol (2)
$C_6H_4CH_3NO_2$ o (nitro toluene)(19)
" m " " (19)
" p " " (19)

$C_6H_3CH_3(NO_2)_2$ 1.2.4(di nitro toluene (5)(20)(24)
$C_6H_5CH:CHCOOH$ (Cinnamic acid)(22)
$CH_3CONHC_6H_5$ (acetanilide)(9)
$CH_3CONHC_6H_4OC_2H_5$ (phenacetine)(5)(8)
$(CH_3)_2CHC_6H_3CH_3OH$ (thymol)(12)
$(CH_3)_2.C.(SO_2C_2H_5)_2$(sulfonal)(9)
$C_6H_5.C_6H_5$ (di phenyl(1)(6)
$C_6H_5OHCOOC_6H_5$ (salol)(5)(8)
$C_{10}H_8$ (naphthalene(1)
$C_{10}H_7OH$ (α naphthol)(1)
$C_{10}H_{19}OH$ (menthol)(8)
$C_{11}H_{12}ON_2$ (antipyrine)(5)(8)
$C_{20}H_{24}N_2O_2$ (quinine) (5)(8)
Urethan + Phenol (13)
" + Salicylic acid (13)
" + Phenacetine (17)(18)
" + Antipyrine (11)(18)
Resorcinol + Antipyrine (17)(18)
Benzoic acid + Resorcinol (14)
Salicylic acid + Antipyrine (17)(18)
" " + Acetanilide (15)
Acetanilide + Phenacetine (17)(18)
" + β Naphthol (15)
Sulfonal + Phenacetine (17)(18)
" + Antipyrine (16)
" + Salipyrine (16)
Antipyrine + " (17)(18)
" + Phenacetine (17)(18)


(1) Puschin and König, 1928
(2) " " Rikovsky, 1932
(3) " " Dezelic, 1932
(4) " " Sladovic, 1928
(5) Adamanis, 1933
(6) Giua, 1916
(7) Brady and Truszkowski, 1924
(8) Hrynakowski and Adamanis, 1933
(9) " " " 1933(a)
(10) " " " 1933(b)
(11) " " " 1935
(12) " " Szmyt, 1935
(13) " " " 1935(a)
(14) " " " 1935(b)
(15) " " " 1935(c)
(16) " " " 1938(a)
(17) Hrynakowski, 1934
(18) " 1934(a)
(19) Kremann, 1907
(20) " and Petritschek, 1917
(21) " " Rodenis, 1906
(22) " Weber and Zechner, 1925
(23) Philip, 1903
(24) Rheinboldt and Kirscheisen, 1926
(25) " Henning and " , 1925
(26) Jänecke and Rahlfs, 1930
(27) " " 1932
(28) Pratolonga, 1914.
(29) " Jänecke and Rahlfs, 1930
(30) van der Hammen, 1931
(31) Van Dorf, Limburg and Nobel, 1937

**UREA PHOSPHATE** $CO(NH_2)_2.H_3PO_4$.

SOLUBILITY OF UREA PHOSPHATE IN WATER AND IN METHYL AND ETHYL ALCOHOLS.
(Matignon and Dode, 1932, 1934.)

Results for:

| Water | | | Methyl Alcohol | | | Ethyl Alcohol | | |
|---|---|---|---|---|---|---|---|---|
| $t^0$ | d. of sat. sol. | Gms. $CO(NH_2).H_3PO_4$ per 100 gms. sat. sol. | $t^0$ | d. of sat. sol. | Gms. $CO(NH_2)_2.H_3PO_4$ per 100 gms. sat. sol. | $t^0$ | d. of sat. sol. | Gms. $CO(NH_2)_2.H_3PO_4$ per 100 gms. sat. sol. |
| 10 | 1.18 | 41.4 | 10 | 0.925 | 25.5 | 10 | 0.83 | 8.3 |
| 13 | 1.20 | 44.0 | 13 | 0.93 | 27.4 | 13 | 0.835 | 9.1 |
| 18 | 1.24 | 47.9 | 18 | 0.94 | 30.2 | 18 | 0.85 | 10.4 |
| 24.5 | 1.26 | 52.4 | 24.5 | 0.98 | 34.6 | 24.5 | 0.85 | 13.0 |
| 32 | 1.29 | 57.5 | 32 | 1.00 | 40.9 | 32 | 0.86 | 16.6 |
| 46 | 1.32 | 66.9 | 46 | 1.07 | 52.9 | 46 | 0.91 | 28.1 |

Results are also given for the fusion points of the system $CO(NH_2)_2$ + $CO(NH_2)_2.H_3PO_4$. The eutectic is at 72° and 37 percent $CO(NH_2)_2$.

**NITROGUANIDINE** $NH_2.C(NH).NH.NO_2$.

One liter of saturated solution of Nitroguanidine in Water contains 4.4 gms. $CH_4O_2N_4$ at 25° and 82.5 gms. at 100°.

One liter of saturated solution in aqueous 1.0 normal KOH contains 12.2 gms. $CH_4O_2N_4$ at 25°. Some decomposition occurs as indicated by the evolution of ammonia. There are two forms of nitroguanidine which differ slightly in solubility. (Davis, Ashdown and Couch, 1925.)

SOLUBILITY IN AQUEOUS SOLUTIONS OF SULFURIC ACID.

Results at 0° and at 25°.
(Davis, 1922.)

| Per cent conc. of aq. $H_2SO_4$. | Gms. $NH_2.C(NH)NH.NO_2$ per 100 cc. sat. sol., at 0°. | at 25°. |
|---|---|---|
| 0 (= $H_2O$) | 0.12 | 0.42 |
| 15 | 0.30 | 0.55 |
| 20 | 0.45 | 1.05 |
| 25 | 0.75 | 1.8 |
| 30 | 1.3 | 2.9 |
| 35 | 2.0 | 5.2 |
| 40 | 3.4 | 8.0 |
| 45 | 5.8 | 10.9 |

Results at 13°.
(Ewan and Young, 1921.)

| Per cent conc. of aq. $H_2SO_4$. | Gms. $NH_2.C(NH)NHNO_2$ per 100 gms. aq. $H_2SO_4$. |
|---|---|
| 5.8 | 0.37 |
| 17.2 | 0.65 |
| 20.0 | 0.72 |
| 22.7 | 0.87 |
| 25.2 | 0.95 |
| 28.2 | 1.37 |
| 33.2 | 2.55 |

In the case of the determinations by Davis an excess of solid was shaken with the aqueous acid and the saturated solution analyzed. The determinations by Ewan and Young were made by adding 82 % $H_2SO_4$ to definite mixtures of nitro guanidine and water untill the solid just dissolved. These authors also give a few determinations made with aqueous nitric acid mixtures.

## METHIONIC ACID $CH_2(SO_3H)_2$

100 gms. $H_2O$ dissolve 245.8 gms. $CH_2(SO_3H)_2$ at 25°. (Backer, 1929, 1930.)

## METHANE SULFONIC ACID $CH_3SO_3H$.

RECIPROCAL SOLUBILITY OF METHANE SULFONIC ACID AND WATER DETERMINED BY THE FREEZING-POINT METHOD.
(Berthoud, 1929.)

| t° | Gm. Mol. Percent $CH_3SO_3H$ | Solid Phase |
|---|---|---|
| - 1.8 | 0.29 | Ice |
| -17.0 | 5.75 | " |
| -27.5 | 8.15 | " |
| -42.0 | 11.1 | " |
| -75.0 Eutec | 16.4 | " + $CH_3SO_3H.3H_2O$ |
| -67.6 | 18.2 | $CH_3SO_3H.3H_2O$ |
| -64.0 | 19.1 | " |
| -53.5 | 24.4 | " |
| -51.7 m.pt. | 23.8 | " |
| -52 | 27.6 | " |
| -54.0 | 31.0 | " |
| -54.5 Eutec | 31.5 | " + $CH_3SO_3H.H_2O$ |
| -51.0 | 32.1 | $CH_3SO_3H.H_2O$ |
| -30.9 | 36.9 | $CH_3SO_3H.H_2O$ |
| -15.3 | 40.3 | " |
| + 1.5 | 45.5 | " |
| 9.8 | 47.8 | " |
| 11.0 m.pt. | 51.1 | " |
| 10.7 | 52.9 | " |
| 3.2 | 61.8 | " |
| -12.0 | 76.3 | " |
| -14.5 | 77.5 | " |
| -15.0 Eutec | 78.0 | " + $CH_3SO_3.H$ |
| -13.6 | 78.0 | $CH_3SO_3H$ " |
| - 8.5 | 83.3 | " |
| + 6.0 | 89.2 | " |
| 20.0 | 100.0 | " |

## METHYL AMINE $CH_3NH_2$.

The solubility of methyl amine in water at 60°, determined by an aspiration method and calculated from the vapor pressure of 40.6 mm Hg, is 419 in terms of the Bunsen Abs. Coef (see p. 37 ) and 511 in terms of the Ostwald Solubility Expression (see p. 37 ) (Doyer, 1890)

Freezing-point data for mixtures of $CH_3NH_2$ + $H_2O$ are given by Pickering, 1893.

DISTRIBUTION OF METHYL AMINE AT 25° BETWEEN : (Smith, 1921, 1922.)

Water and Chloroform.

| Millimols. $CH_3NH_2$ per liter. | | |
|---|---|---|
| $H_2O$ layer ($C_1$). | $CHCl_3$ layer ($C_2$). | $\frac{C_2}{C_1}$. |
| 2.625 | 0.475 | 0.181 |
| 6.15 | 1.225 | 0.199 |
| 13.5 | 1.9 | 0.141 |
| 27.4 | 4.5 | 0.164 |

Water and Ether.

| Millimols. $CH_3NH_2$ per liter. | | |
|---|---|---|
| $H_2O$ layer ($C_1$). | $(C_2H_5)_2O$ layer ($C_2$). | $\frac{C_2}{C_1}$. |
| 4.90 | 0.575 | 0.117 |
| 7.60 | 0.90 | 0.118 |
| 11.25 | 1.225 | 0.109 |
| 19.1 | 2.05 | 0.107 |
| 34.5 | 3.9 | 0.113 |

Water and Xylene.

| Millimols. $CH_3NH_2$ per liter | | |
|---|---|---|
| $H_2O$ layer ($C_1$). | $C_6H_4(CH_3)_2$ layer ($C_2$). | $\frac{C_2}{C_1}$. |
| 1.730 | 0.130 | 0.0750 |
| 3.745 | 0.255 | 0.0680 |
| 4.990 | 0.501 | 0.0528 |
| 19.018 | 0.982 | 0.0517 |

## Distribution of Methyl Amine Between Water and Chloroform.

### Results at Several Temperatures

(Moore and Winmill, 1912.)

| $t^0$ | Gm. Equiv. $CH_3NH_2$ per liter aq. layer | Partition Coef. | Gms. $CH_3NH_2$ per liter: $H_2O$ layer($C_1$) | Gms. $CH_3NH_2$ per liter: $CHCl_3$ layer($C_2$) | $\frac{C_1}{C_2}$ |
|---|---|---|---|---|---|
| 18 | 0.0817 | 8.496 | 0.02113 | 0.001521 | 13.80 |
| " | 0.0909 | 8.477 | 0.06876 | 0.005611 | 12.25 |
| 25 | 0.1203 | 7.965 | 0.10151 | 0.008380 | 12.11 |
| " | 0.1312 | 8.0 | 0.2003 | 0.01682 | 11.90 |
| 32.35 | 0.1399 | 5.99 | 0.3793 | 0.03242 | 11.70 |
| " | 0.0959 | 6.0 | 0.6850 | 0.05940 | 11.53 |

### Results at 25°

(Felsing and Buckley, 1933.)

| Gms. $CH_3NH_2$ per liter: $H_2O$ layer($C_1$) | Gms. $CH_3NH_2$ per liter: $CHCl_3$ layer($C_2$) | $\frac{C_1}{C_2}$ |
|---|---|---|
| 0.9741 | 0.08473 | 11.50 |
| 1.2773 | 0.1126 | 11.34 |
| 1.5563 | 0.1379 | 11.28 |
| 1.7485 | 0.1551 | 11.27 |
| 2.0384 | 0.1834 | 11.11 |
| 2.6180 | 0.2402 | 10.90 |

Results for the distribution of methyl amine between aqueous 0.05 molar copper sulfate and chloroform at 25° are given by Felsing and Buckley, 1933.

## Distribution of Methyl Amine at 25° Between:

### Water and Benzene

(Herz and Stanner, 1927.)

| Gm. Mols. $CH_3NH_2$ per liter: $H_2O$ layer($C_1$) | Gm. Mols. $CH_3NH_2$ per liter: $C_6H_6$ layer($C_2$) | $\frac{C_2}{C_1}$ |
|---|---|---|
| 0.5515 | 0.0242 | 0.044 |
| 1.0545 | 0.0424 | 0.040 |
| 1.5636 | 0.0485 | 0.031 |
| 2.0758 | 0.0576 | 0.028 |

### Water and Toluene

(Herz and Stanner, 1927.)

| Gm. Mols. $CH_3NH_2$ per liter: $H_2O$ layer($C_1$) | Gm. Mols. $CH_3NH_2$ per liter: $C_6H_5CH_3$ layer($C_2$) | $\frac{C_2}{C_1}$ |
|---|---|---|
| 0.5382 | 0.0242 | 0.045 |
| 1.0091 | 0.0364 | 0.036 |
| 1.5061 | 0.0424 | 0.028 |
| 2.0169 | 0.0667 | 0.033 |

## Distribution of Methyl Amine at 25° Between Water and Amyl Alcohol.

(Herz and Fischer, 1904.)

| Gms. $CH_3NH_2$ per liter: $H_2O$ layer | Gms. $CH_3NH_2$ per liter: $C_5H_{12}O$ layer |
|---|---|
| 3.70 | 1.20 |
| 9.40 | 3.30 |
| 15.7 | 5.4 |
| 20.0 | 7.2 |
| 25.3 | 9.2 |
| 33.0 | 12.4 |

| Gm. Mols. $CH_3NH_2$ per liter: $H_2O$ layer | Gm. Mols. $CH_3NH_2$ per liter: $C_5H_{12}O$ layer |
|---|---|
| 0.1155 | 0.03804 |
| 0.3036 | 0.1070 |
| 0.5054 | 0.1759 |
| 0.6429 | 0.2315 |
| 0.8126 | 0.2981 |
| 1.0613 | 0.3974 |

## TETRA CHLORO ETHYLENE $CCl_2:CCl_2$.

CRITICAL SOLUTION TEMPERATURES OF MIXTURES OF TETRACHLOR ETHYLENE AND OTHER COMPOUNDS.
(Cornish, Archibald, Murphy and Evans, 1934.)

| Mixture | | Crit. Solution Temp. |
|---|---|---|
| $CCl_2:CCl_2$ + $CH_3CN$ | (Acetonitrile) | 13. |
| " + $NH_2CH_2CH_2NH_2$ | (Ethylene diamine) | 15.8 |
| " + $HOCH_2CH_2Cl$ | (Glycol chlor hydrine) | 30. |
| " + $CH_3NO_2$ | (Nitro methane) | 41. |

## HEXA CHLORO ETHANE $CCl_3:CCl_3$.

Results for the solubility of hexa chloro ethane in ethane, liquid and vapor, over a temperature range from 40° to 50° are given by Holder and Maass, 1940. An apparatus consisting of a central main phosphor bronze bomb in which the solvent and solute were placed and to which two small bombs equipped with needle valves were attached, was used for measuring the solubilities both in the liquid and vapor phases up to and above the critical temperature.

The critical solution temperature of this system $C_2Cl_6$ + $C_8H_{10}O_4$ (ethyl oxalate) is at about 105°. (Lecat, 1928.)

Results for the melting points of the system $CCl_3:CCl_3$ + $C_{10}H_8$ (Naphthalene) are given by Parijs, 1936.

## TETRA CHLORO DINITRO ETHANE $C_2(NO_2)_2Cl_4$.

30 cc. of dry nitrogen peroxide ($N_2O_4$), distilled from $P_2O_5$, dissolve 15.7 gms. $C_2(NO_2)_2Cl_4$ at 0°. The solubility of tetrachlor dinitro ethane in superpalite and in chlorpierin is about of the same order of magnitude.
(Argo, James and Donnelly, 1919.)

## CYANOGEN AZIDO DITHIOCARBONATE $CN.SCSN_3$.

SOLUBILITY OF CYANOGEN AZIDO DITHIO-CARBONATE IN SEVERAL SOLVENTS AT 0°.
(Audrieth and Browne, 1930.)

Solutions saturated at room temperature were cooled in an ice bath and after crystallization 5 cc samples of the supernatant liquid were withdrawn, the solvent removed by evaporation, and the residue weighed.

| Solvent | Gms. $CN.SCSN_3$ per 100 cc sat. sol. | Solvent | Gms. $CN.SCSN_3$ per 100 cc sat. sol. |
|---|---|---|---|
| Water | 0.15 | Chloroform | 3.17 |
| Carbon tetra chloride | 0.22 | Methyl Alcohol | 6.27 |
| Carbon disulfide | 0.29 | Ethyl Acetate | 13.19 |
| Ethyl Ether | 1.11 | Acetone | 24.69 |
| Ethyl Alcohol | 2.61 | | |

## TRI BROMO DI CHLORO ETHANES

Freezing-point data for the system $CH\ BR_2.C\ Cl_2\ Br$ + $CH\ Cl\ Br.C\ Cl\ Br_2$ are given by Van de Walle, 1925.

## PER CHLORO ETHANE $CCl_3CCl_3$.

100 gms. $H_2O$ dissolve 0.005(?) gm. $CCl_3CCl_3$ at 22.3°. (Van Arkel and Vles, 1936.)

## PENTA CHLORO ETHANE $CHCl_2CCl_3$.

100 gms. $H_2O$ dissolve 0.047 gm. $CHCl_2CCl_3$ at 20°. (Van Arkel and Vles, 1936.)

The critical solution temperature of mixtures of Penta chloro Ethane and Acetamid is at about 95°. (Lecat, 1928.)

Freezing-point data are given for the systems $C_2HCl_5$ + $CH_2ClCH_2Cl$ (Ethylene Chloride) and $C_2HCl_5$ + $CHCl_2{:}CHCl_2$ (1.1.2.2.-tetrachloro ethane) by Timmermans and Mme. Vesselovsky, 1931.

## TRI CHLORO ETHYLENE $C_2HCl_3$.

### Solubility of Water in Tri Chloro Ethylene.
(Carlisle and Levine, 1932.)

The authors give their results in the form of a curve from which the following results were read.

| t° | Gms. $H_2O$ per 100 gms. sat. sol. | t° | Gms. $H_2O$ per 100 gms. sat. sol. |
|---|---|---|---|
| −38 | 0.0008 | +10 | 0.0165 |
| −26 | 0.003 | 22 | 0.0270 |
| −14 | 0.006 | 28 | 0.0333 |
| − 2 | 0.010 | | |

## CHLORAL $CCl_3CHO$.

Freezing-point data are given for:

$CCl_3.CHO + H_2O$ (van Rossem, 1908.)
$CCl_3.CHO + C_2H_5OH$ (Leopold, 1909.)

## TRI CHLORO ACETIC ACID $CCl_3COOH$.

100 gms. sat. solution of tri chloro acetic acid in water has the $d_{25}$ = 1.615 and contains 92.32 gms. $CCl_3COOH$ at 25°. (Seidell, 1910.)

Results for the reciprocal solubility of tri chloro acetic acid and water determined by the freezing-point method are given by Pickering, 1895.

### Equilibrium in the System Trichloro Acetic Acid Benzene and Water at 15°.

(Bell, 1930.)

| d. of sat. solution | Gm. Mols. per 1000 gms. sat. sol. $CCl_3COOH$ | $H_2O$ | d. of sat. solution | Gm. Mols. per 1000 gm. sat. sol. $CCl_3COOH$ | $H_2O$ |
|---|---|---|---|---|---|
| 0.878 | 0.0278 | 0.0426 | 0.885 | 0.140 | 0.165 |
| 0.878 | 0.0506 | 0.0690 | 0.888 | 0.176 | 0.210 |
| 0.887 | 0.0950 | 0.115 | 0.892 | 0.219 | 0.247 |

### Distribution of Tri Chloracetic Acid at 25° Between: (Smith, 1921-1922.)

#### Water and Ether.

| Millimols. $CCl_3COOH$ per liter of $H_2O$ layer ($C_1$). | Ether layer ($C_2$). | $\frac{C_2}{C_1}$. |
|---|---|---|
| 1.95 | 0.85 | 0.436 |
| 3.20 | 2.50 | 0.781 |
| 5.10 | 5.40 | 1.060 |
| 7.10 | 10.40 | 1.465 |
| 8.825 | 17.00 | 1.928 |

#### Acetone and Glycerol.

| Millimols. $CCl_3COOH$ per liter of Acetone layer (A). | Glycerol layer (G). | $\frac{A}{G}$. |
|---|---|---|
| 1.50 | 0.600 | 2.50 |
| 2.8375 | 0.7625 | 3.72 |
| 5.40 | 1.075 | 5.02 |
| 7.70 | 1.25 | 6.17 |
| 20.90 | 1.70 | 12.30 |

### Distribution of Tri Chloracetic Acid at 25° Between:

(Kolossowsky and Kulikow, 1934, 1934a.)

#### Water and Carbon Tetrachloride

| Gm. Equiv. $CCl_3COOH$ per liter of $H_2O$ layer($C_1$) | $CCl_4$ layer($C_2$) | $\frac{C_1}{C_2}$ |
|---|---|---|
| 0.2772 | 0.0012 | 231 |
| 0.6237 | 0.0063 | 99 |
| 0.8392 | 0.0183 | 50.4 |
| 1.2285 | 0.0268 | 45.8 |
| 2.0034 | 0.0598 | 33.5 |
| 3.1972 | 0.0949 | 33.8 |
| 4.1126 | 0.1169 | 35.2 |
| 5.5014 | 0.3391 | 16.2 |
| 5.600 | 0.6388 | 8.77 |

#### Water and Chloroform

| Gm. Equiv. $CCl_3COOH$ per liter of $H_2O$ layer($C_1$) | $CHCl_3$ layer($C_2$) | $\frac{C_1}{C_2}$ |
|---|---|---|
| 0.0488 | 0.0017 | 28.71 |
| 0.1716 | 0.0094 | 18.26 |
| 0.2960 | 0.0218 | 13.58 |
| 0.4673 | 0.0512 | 9.13 |
| 0.7617 | 0.1119 | 6.81 |
| 1.1708 | 0.2238 | 4.83 |
| 2.0781 | 0.5490 | 3.79 |
| 3.1401 | 0.8114 | 3.87 |
| 3.6039 | 1.0011 | 3.60 |

## Distribution of Trichloro Acetic Acid at 25° Between:

(Kolossowski and Koulikow, 1934a.)

### Water and Methyl Iodide

| Gm. Equiv. $CCl_3COOH$ per liter of $H_2O$ layer ($C_1$) | Gm. Equiv. $CCl_3COOH$ per liter of $CH_3I$ layer ($C_2$) | $\frac{C_1}{C_2}$ |
|---|---|---|
| 0.1974 | 0.0080 | 24.70 |
| 0.3345 | 0.0211 | 15.85 |
| 0.5638 | 0.0544 | 10.36 |
| 0.839 | 0.124 | 6.77 |
| 1.650 | 0.544 | 3.03 |
| 2.594 | 0.981 | 2.64 |
| 3.440 | 1.324 | 2.60 |
| 3.174 | 1.933 | 1.64 |
| 2.931 | 2.167 | 1.35 |

### Water and Ethyl Bromide

| Gm. Equiv. $CCl_3COOH$ per liter of $H_2O$ layer ($C_1$) | Gm. Equiv. $CCl_3COOH$ per liter of $C_2H_5Br$ layer ($C_2$) | $\frac{C_1}{C_2}$ |
|---|---|---|
| 0.063 | 0.0069 | 9.13 |
| 0.146 | 0.030 | 4.87 |
| 0.272 | 0.076 | 3.58 |
| 0.496 | 0.178 | 2.79 |
| 0.699 | 0.285 | 2.45 |
| 1.017 | 0.530 | 1.92 |
| 1.548 | 1.305 | 1.19 |
| 1.809 | 2.003 | 0.90 |
| 2.481 | 2.901 | 0.86 |

### Water and Toluene

| Gm. Equiv. $CCl_3COOH$ per liter of $H_2O$ layer ($C_1$) | Gm. Equiv. $CCl_3COOH$ per liter of $C_6H_5CH_3$ layer ($C_2$) | $\frac{C_1}{C}$ |
|---|---|---|
| 0.0690 | 0.0015 | 46.0 |
| 0.0910 | 0.00225 | 40.4 |
| 0.1400 | 0.0038 | 36.8 |
| 0.2223 | 0.0076 | 29.3 |
| 0.4185 | 0.0233 | 18.0 |
| 0.7275 | 0.0597 | 12.2 |
| 1.1565 | 0.1505 | 7.68 |
| 1.5794 | 0.2922 | 5.41 |
| 2.2074 | 0.5198 | 4.25 |
| 2.9380 | 0.6952 | 4.23 |
| 3.7103 | 0.9887 | 3.75 |
| 4.1598 | 1.2312 | 3.38 |

### Water and Cumene

| Gm. Equiv. $CCl_3COOH$ per liter of $H_2O$ layer ($C_1$) | Gm. Equiv. $CCl_3COOH$ per liter of $C_6H_5CH(CH_3)_2$ layer ($C_2$) | $\frac{C_1}{C_2}$ |
|---|---|---|
| 0.1215 | 0.0220 | 5.52 |
| 0.1588 | 0.0300 | 5.29 |
| 0.407 | 0.081 | 5.02 |
| 0.680 | 0.150 | 4.53 |
| 0.819 | 0.189 | 4.33 |
| 1.046 | 0.277 | 3.78 |
| 1.298 | 0.359 | 3.62 |
| 1.751 | 0.529 | 3.31 |
| 2.029 | 0.611 | 3.32 |
| 2.545 | 0.693 | 3.67 |
| 4.001 | 0.806 | 4.96 |
| 4.599 | 0.779 | 5.96 |

### Water and Nitrobenzene

| Gm. Equiv. $CCl_3COOH$ per liter of $H_2O$ layer ($C_1$) | Gm. Equiv. $CCl_3COOH$ per liter of $C_6H_5NO_2$ layer ($C_2$) | $\frac{C_1}{C_2}$ |
|---|---|---|
| 0.0186 | 0.0031 | 6.02 |
| 0.0485 | 0.0088 | 5.51 |
| 0.0831 | 0.0181 | 4.59 |
| 0.1057 | 0.0286 | 3.70 |
| 0.2206 | 0.0945 | 2.33 |
| 0.3774 | 0.2487 | 1.52 |
| 0.5884 | 0.5551 | 1.08 |
| 0.7741 | 0.9431 | 0.821 |
| 1.0011 | 1.6614 | 0.603 |
| 1.2548 | 2.7421 | 0.458 |
| 1.4519 | 3.4728 | 0.418 |
| 1.6129 | 3.7090 | 0.435 |

### Water and o Nitrotoluene

| Gm. Equiv. $CCl_3COOH$ per liter of $H_2O$ layer ($C_1$) | Gm. Equiv. $CCl_3COOH$ per liter of o $C_6H_4CH_3NO_2$ layer ($C_2$) | $\frac{C_1}{C_2}$ |
|---|---|---|
| 0.0508 | 0.0054 | 9.41 |
| 0.0819 | 0.0121 | 6.77 |
| 0.140 | 0.0317 | 4.42 |
| 0.248 | 0.083 | 2.99 |
| 0.376 | 0.176 | 2.14 |
| 0.788 | 0.747 | 1.06 |
| 1.164 | 1.304 | 0.89 |
| 1.395 | 1.956 | 0.71 |
| 1.559 | 2.539 | 0.61 |
| 2.110 | 4.323 | 0.49 |
| 2.384 | 4.392 | 0.54 |
| 2.580 | 3.504 | 0.74 |

## TRICHLOR ACETIC ACID

### Distribution of Trichlor Acetic Acid at 25° Between:
(Kolossowski and Koulikow, 1934, 1934a.)

Water and n Amyl Alcohol

| Gms. Equiv. $CCl_3COOH$ per liter of: $H_2O$ layer($C_1$) | Gms. Equiv. $CCl_3COOH$ per liter of: n $C_5H_{11}OH$ layer($C_2$) | $\frac{C_1}{C_2}$ |
|---|---|---|
| 0.0045 | 0.0208 | 0.216 |
| 0.0069 | 0.0350 | 0.197 |
| 0.0095 | 0.0600 | 0.158 |
| 0.0313 | 0.2590 | 0.121 |
| 0.0460 | 0.4605 | 0.100 |
| 0.0607 | 0.7194 | 0.084 |
| 0.0964 | 1.3213 | 0.073 |
| 0.1225 | 1.8635 | 0.066 |
| 0.2114 | 2.7359 | 0.077 |
| 0.2406 | 2.9473 | 0.082 |
| 0.4539 | 3.4821 | 0.130 |
| 0.8736 | 3.7121 | 0.235 |

Water and i Amyl Alcohol

| Gms. Equiv. $CCl_3COOH$ per liter of: $H_2O$ layer($C_1$) | Gms. Equiv. $CCl_3COOH$ per liter of: i $C_5H_{11}OH$ layer($C_2$) | $\frac{C_1}{C_2}$ |
|---|---|---|
| 0.0284 | 0.0426 | 0.667 |
| 0.0319 | 0.1084 | 0.294 |
| 0.0456 | 0.2342 | 0.195 |
| 0.0581 | 0.3129 | 0.186 |
| 0.0749 | 0.4456 | 0.168 |
| 0.0939 | 0.6031 | 0.156 |
| 0.1347 | 1.3580 | 0.099 |
| 0.1709 | 2.1763 | 0.0785 |
| 0.2736 | 3.0048 | 0.091 |
| 0.4726 | 3.9484 | 0.120 |
| 0.6697 | 4.4987 | 0.149 |
| 1.1752 | 5.0055 | 0.235 |

In the above systems the aqueous is the lower layer in the case of the first eight results and the upper layer in the case of the last four.

Water and Benzyl Alcohol

| Gm. Equiv $CCl_3COOH$ per liter of: $H_2O$ layer($C_1$) | Gm. Equiv $CCl_3COOH$ per liter of: $C_6H_5CH_2OH$ layer($C_2$) | $\frac{C_1}{C_2}$ |
|---|---|---|
| 0.0087 | 0.0174 | 0.500 |
| 0.0375 | 0.1216 | 0.308 |
| 0.0715 | 0.3513 | 0.204 |
| 0.1005 | 0.5627 | 0.179 |
| 0.1586 | 1.0944 | 0.145 |

Water and Benzyl Alcohol (Con.)

| Gm. Equiv. $CCl_3COOH$ per liter of $H_2O$ layer($C_1$) | Gm. Equiv. $CCl_3COOH$ per liter of $C_6H_5CH_2OH$ layer($C_2$) | $\frac{C_1}{C_2}$ |
|---|---|---|
| 0.2518 | 1.7286 | 0.146 |
| 0.3824 | 2.4312 | 0.157 |
| 0.5347 | 2.9846 | 0.179 |
| 0.8540 | 3.6064 | 0.237 |
| 1.0489 | 3.9084 | 0.268 |

### Distribution of Trichloro Acetic Acid Between Water and Olive Oil.
(Bodansky and Meigs, 1932.)

| t° | Gm. Mols. $CCl_3COOH$ per liter of: $H_2O$ layer($C_t$) | Olive Oil Layer($C_2$) | $\frac{C_1}{C_2}$ |
|---|---|---|---|
| 25 | 0.0820 | 0.0170 | 4.60 |
| 37 | 0.0792 | 0.0224 | 3.53 |

Freezing-point data are given for mixtures of Trichloro Acetic Acid and each of the following compounds.

Acetophenone(1)
Anisaldehyde(1)
Azobenzene(11)
Benzene (2)
Benzaldehyde(1)
m Hydroxy Benzaldehyde(1)
p " " (1)
o Nitro " (1)
m " " (1)
p " " (1)
Benzophenone(1)
Benzil(1)
Benzoquinone(1)
Benzoic Acid(3)
Camphene(4)
Camphor(10)
Chloro Acetic Acid(16)
Dichloro " " (16)
Cinnamic Acid(3)
Crotonic Acid(3)
o Cresol(3)
m " (3)
p " (3)
Diethyl Oxalate(2)
" Succinate(2)
Dimethyl Oxalate(2)
" Malonate(2)
" Succinate(2)
" Terephthalate(2)
" Pyrone(5)(6)
Diphenylamine (10)
Erythritol(12)
Ethyl Ether(7)
" Acetate(2)
" Benzoate(2)
Methyl Anisate(2)
" Benzoate(2)
" Cinnamate(2)
" p Toluate(2)
Naphthalene(10)
α Naphthol(8)
β " (8)
α Naphthyl Acetate(2)
β " " (2)
β Naphthyl amine(10)
Phenol(8)
o Nitro Phenol(8)
m " " (8)
p " " (8).
Piperonal(1)
Nitro Piperonal(1)
Phenyl Anisylketone(1)
" Benzoate(2)
" Salicylate(2)
Phosphoric Acid(15)
Pyrocatechol(10)
Pyrogallol(10)
Quinol(10)
Resorcinol(10)
Salicylic Aldehyde(2)
Sulfuric Acid (9)
Thymol(8)
o Toluic Acid(3)
m " " (3)
p " " (3)
α " " (3)
Urea(13)(14).
Urethan(10)(14)
Vanillin(1)

(1) Kendall and Gibbons, 1915; (2) Kendall and Booge, 1916; (3) Kendall, 1914; (4) Timofeiew and Kravtzov, 1915,1917; (5) Plotnikov, 1911; (6) Kendall, 1914a; (7) Tsakalotos and Guye, 1910; (8) Kendall, 1916; (9) Kendall and Carpenter, 1914; (10) Kitran, 1924; (11) Kremann and Zechner, 1925; (12) Puschin and Dezelic, 1932; (13) Puschin and König, 1928; (14) Puschin and Rikovsky, 1932; (15) Redfield and King, 1936, Kendall, 1914.

## ACETYLENE $C_2H_2$.

### Solubility in Water.

The results of Winkler, 1906, Schœn, 1923, Manchot, 1924 (25°) and Gatterer, 1926, were plotted and the following values read from the smoothed curve.

| t°. | Absorption coefficient *a*. | t°. | Absorption coefficient *a*. | t°. | Absorption coefficient *a*. |
|---|---|---|---|---|---|
| 0..... | 1.73–1.77 | 20..... | 1.05 | 40..... | 0.71 |
| 5..... | 1.49–1.52 | 25..... | 0.94 | 45..... | 0.65 |
| 10..... | 1.31–1.33 | 30..... | 0.85 | 50..... | 0.61 |
| 15..... | 1.16–1.17 | 35..... | 0.77 | 55..... | 0.57 |

*Absorption Coefficient a* = the volume of gas (reduced to 0° and 760 mm. pressure) taken up by one volume of the liquid at the given temperature when the partial pressure of the gas equals 760 mm. mercury.

### Solubility of Acetylene in Blood and in Blood Serum. (Schœn, 1923.)

In Blood.

| t° | Abs. coef *a*. | t°. | Abs. coef. *a*. |
|---|---|---|---|
| 9.5... | 1.305 | 37... | 0.731–0.739 |
| 10.0... | 1.302 | 38... | 0.720 |
| 15.0... | 1.136–1.140 | 39... | 0.703 |

In Blood Serum

| t°. | Abs. coef. *a* |
|---|---|
| 10..... | 1.280 |
| 10.5... | 1.271 |
| 11.0 .. | 1.244–1.256 |

### Solubility of Acetylene in Aqueous Solutions of Prussian Blue.

(Gatterer, 1926.)

The Prussian Blue solution (Ferri ferrocyanide) was prepared by mixing 2.0 normal sodium ferrocyanide and ferric chloride, washing the resulting precipitate, redissolving in a small quantity of ferrocyanide solution and evaporating in a vacuum to a concentration of about 8 per cent. For purposes of calculation the gram equivalent of Prussian Blue was taken as $^1/_2Fe_4[Fe(CN)_6]_3 = 71.603$. The solubility of the acetylene is given in terms of the *Ostwald Solubility Expression l*, which is the volume of gas dissolved by unit volume of solvent at the temperature of the experiment.

| Normality of Prussian Blue Solution. | Solubility $l$ of $C_2H_2$ at 30°. | 25°. | 20°. | 15°. | 10°. |
|---|---|---|---|---|---|
| 0.0 (= $H_2O$) | 0.952 | 1.030 | 1.126 | 1.239 | 1.382 |
| 0.250 | 0.9289 | 1.007 | 1.102 | 1.212 | 1.358 |
| 0.548 | 0.9149 | 0.9937 | 1.088 | 1.199 | 1.339 |
| 0.750 | 0.9010 | 0.9760 | 1.071 | 1.179 | 1.282 |
| 1.028 | 0.8816 | 0.9527 | 1.044 | 1.145 | 1.282 |

### Solubility of Acetylene in Aqueous Solutions of Ferric Hydroxide.

(Gatterer, 1926.)

In order to prepare the solvents a solution of pure ferric hydroxide in acetic acid was diluted and boiled untill the ratio of acetic acid to ferric hyroxide became 1:30-1:60. It was then evaporated under reduced pressure, whereby a much higher degree of dispersion, as shown by the Tyndall effect, was obtained. The gram equivalent of the ferric hydroxide was taken as $^1/_3Fe(OH)_3 = 35.621$.

| Normality of Ferric Hydroxide solution. | Solubility $l$ of $C_2H_2$ at 30°. | 25°. | 20°. | 15°. | 10°. |
|---|---|---|---|---|---|
| 0.871 | 0.9400 | 1.018 | 1.111 | 1.227 | 1.364 |
| 0.521 | 0.9360 | 1.016 | 1.111 | 1.224 | 1.364 |
| 0.336 | 0.9495 | 1.029 | 1.126 | 1.241 | 1.383 |
| 0.120 | 0.9450 | 1.024 | 1.126 | 1.236 | 1.379 |

### Solubility of Acetylene in Aqueous Solutions of Salts at 25°.

(Manchot, Jahrstorfer and Zepter. 1924.)

Note. — An apparatus designed to climinate the disadvantages of the Ostwald type was used. The gas volumes were measured in a water-jacketed mercury scaled gas buret. An absorption flask, provided with a separate rec ptiele for the solvent, was connected to the gas buret by glass tubing made sufficiently flexible either by a grid or by two short rubber connections. The apparatus was filled with the pure gas and this then saturated with the vapor of a small portion of the solvent. The reading was taken and the main portion of the solvent introduced and the volume of gas that it dissolved measured directly. The rubber connections of the apparatus were soaked in paraffine to render them impervious to the gas.

The authors desired to compare the amount of gas dissolved per unit weight of water in the salt solutions employed, rather than per unit volume of solution. The densities of the salt solutions were, therefore, determined. The original tables show the *absorption coefficient a* (See p. 71 ) calculated not only to unit

volume of solution but also to unit weight of solution. Further calculations per mitted deductions in regard to the $H_2O$ of hydration of the salts studied.

| Salt. | $d_{25}$ of salt. sol. | Gms. anhy. salt. per 100 cc. sol. | Abs. coef. *a* per 100 cc. sol. | Salt. | $d_{25}$ of salt. sol. | Gms. anhy. salt. per 100 cc. sol. | Abs. coef. *a* per 100 cc. sol. |
|---|---|---|---|---|---|---|---|
| None (=$H_2O$). | 0.9971 | 0.00 | 94.1 | $NaNO_3$.... | 1.0556 | 9.181 | 78.5 |
| $NH_4Cl$..... | 1.0141 | 5.818 | 82.7 | » .... | 1.1106 | 18.362 | 66.7 |
| » ..... | 1.0294 | 11.631 | 74.7 | » .... | 1.2189 | 36.724 | 49.0 |
| » ..... | 1.0600 | 23.258 | 64.3 | $Ca(NO_3)_2$.. | 1.1503 | 22.398 | 64.8 |
| KCl..... | 1.0807 | 13.757 | 65.3 | » .. | 1.2927 | 44.796 | 44.1 |
| » ..... | 1.1588 | 27.513 | 48.1 | $Zn(NO_3)_2$.. | 1.1210 | 15.700 | 74.5 |
| NaCl..... | 1.0420 | 6.548 | 70.6 | » .. | 1.2406 | 31.401 | 59.7 |
| » ..... | 1.0850 | 13.212 | 54.1 | $Al(NO_3)_3$.. | 1.0822 | 11.846 | 75.5 |
| » ..... | 1.1660 | 26.424 | 32.0 | » .. | 1.1502 | 21.771 | 62.9 |
| $CaCl_2$..... | 1.0806 | 10.593 | 60.6 | $(NH_4)_2SO_4$. | 1.0911 | 18.158 | 52.4 |
| » ..... | 1.1675 | 22.665 | 39.1 | » . | 1.1501 | 30.464 | 36.3 |
| $BaCl_2$..... | 1.1085 | 13.135 | 67.5 | $K_2SO_4$..... | 1.0753 | 10.351 | 64.9 |
| » ..... | 1.2266 | 27.328 | 49.1 | $Na_2SO_4$.... | 1.0538 | 6.640 | 67.0 |
| $MgCl_2$..... | 1.0802 | 10.511 | 58.4 | » .... | 1.1111 | 13.730 | 47.6 |
| » ..... | 1.1501 | 20.265 | 39.7 | $MgSO_4$.... | 1.0999 | 10.792 | 54.8 |
| $FeCl_3$..... | 1.1030 | 13.433 | 63.0 | » .... | 1.1944 | 21.584 | 31.1 |
| » ..... | 1.1638 | 21.558 | 51.6 | $ZnSO_4$..... | 1.1359 | 14.771 | 54.9 |
| $AlCl_3$..... | 1.0672 | 8.3146 | 62.3 | » ..... | 1.2666 | 29.542 | 31.9 |
| » ..... | 1.1150 | 14.349 | 47.1 | $MnSO_4$.... | 1.1283 | 14.747 | 54.8 |
| $NH_4Br$..... | 1.0540 | 10.465 | 84.4 | » .... | 1.2507 | 29.544 | 31.4 |
| » ..... | 1.1100 | 20.931 | 78.8 | $NiSO_4$..... | 1.1096 | 11.42 | 59.9 |
| » ..... | 1.2215 | 41.862 | 68.6 | » .... | 1.2156 | 22.84 | 38.0 |
| KBr..... | 1.0866 | 12.973 | 77.9 | $CoSO_4$..... | 1.1139 | 12.356 | 58.8 |
| » ..... | 1.1750 | 25.947 | 65.5 | » .... | 1.2238 | 24.712 | 37.1 |
| » ..... | 1.3459 | 51.893 | 47.8 | $FeSO_4$..... | 1.1017 | 10.938 | 61.6 |
| NaBr..... | 1.0829 | 11.527 | 72.7 | » ..... | 1.2011 | 21.845 | 41.1 |
| » ..... | 1.1668 | 23.054 | 57.9 | $Al_2(SO_4)_3$.. | 1.1558 | 17.688 | 41.6 |
| » ..... | 1.3307 | 46.108 | 36.1 | » .. | 1.2381 | 27.875 | 25.4 |
| $KNO_3$..... | 1.0618 | 10.8794 | 82.4 | $Fe_2(SO_4)_3$.. | 3.2240 | 26.390 | 45.8 |
| » ..... | 1.1232 | 21.7589 | 73.7 | » .. | 1.4319 | 52.781 | 22.7 |
| $Mg(NO_3)_2$.. | 1.0916 | 14.092 | 74.3 | $Cr_2(SO_4)_3$.. | 1.1657 | 22.356 | 56.7 |
| » .. | 1.1821 | 28.184 | 59.8 | » .. | 1.3280 | 44.712 | 32.4 |

Freezing-point data for mixtures of $C_2H_2$ + $(CH_3)_2O$ are given by Baume, 1924.

## Solubility of Acetylene in Water, Aqueous Solutions of Alkalies and Sulfuric Acid at 15°.

(Billitzer, 1902.)

| Aq. Solution of: | $l_{15}$ of Acetylene in Aq. Solutions of Normality: | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 0.01 | 0.025 | 0.05 | 0.10 | 0.15 | 0.25 | 0.50 | 1.00 | 2.00 | 3.00 |
| $Ba(OH)_2$ | ... | 1.218 | ... | 1.230 | 1.240 | ... | ... | ... | ... | ... |
| $Ca(OH)_2$ | 1.230 | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| $NH_4OH$ | 1.216 | ... | ... | 1.218 | ... | 1.220 | 1.225 | 1.230 | 1.235 | 1.240 |
| NaOH | 1.210 | ... | 1.200 | 1.180 | ... | 1.128 | 1.040 | 0.885 | 0.600 | 0.370 |
| KOH | 1.212 | ... | ... | 1.185 | ... | 1.130 | 1.056 | 0.912 | 0.660 | 0.460 |
| $Na_2SO_4$ | ... | ... | ... | 1.170 | ... | 1.068 | 0.940 | 0.720 | 0.340 | ... |
| $H_2SO_4$ | ... | ... | ... | 1.190 | ... | ... | 1.120 | 1.040 | 0.900 | 0.780 |

Solubility in Water, $l_{15}$ = 1.251.

The above results were determined by the method of Ostwald (Handbuch physiko-chemischen Messungen 207 ff.). A thermostat was used and great care taken to reduce experimental errors and purify the acetylene. The results are in terms of the *Ostwald Solubility Expression*, for which see page 37.

## Solubility of Acetylene in Aqueous Acetone Solutions.

(Kremann and Hönel, 1913; See also Müller and Kumpfmiller, 1928.)

| Vol. Per Cent $H_2O$ in Solvent ($H_2O$ + Acetone). | Gms. $C_2H_2$ dissolved per Liter Sat. Solution at: | | |
|---|---|---|---|
| | 0°. | 18° | 25° |
| 0 | 37 | 21 | 15.2 |
| 5 | 31 | 18.2 | 13.5 |
| 10 | 26 | 15.0 | 10.5 |
| 20 | 15 | 9.5 | 8.0 |
| 35 | 8.4 | 5.5 | 4.45 |
| 50 | 5.7 | 1.23 | 2.22 |
| 75 | ... | ... | 1.23 |
| 100 | ... | ... | 0.98 |

The freezing-point curve for mixtures of acetylene and methyl ether are given by Baume and German (1911, 1914).

## Solubility of Acetylene in Water, Blood and Blood Fluids at 37.5°.

(Grollman, 1929.)

| Solvent | Solubility in terms of the Bunsen Coef. $\beta$ | |
|---|---|---|
| | cc $C_2H_2$ per cc solution | cc $C_2H_2$ per gm. $H_2O$ |
| Water | 0.747 | 0.752 |
| Whole Dog Blood | 0.759 | 0.943 |
| " Human " | 0.740 | 0.916 |
| " Rabbit " | 0.703 | 0.812 |
| " Blood (polycythemia patient) | 0.710 | — |
| " " (mycloid lencemia patient) | 0.735 | 0.881 |
| Dog plasma | 0.690 | 0.751 |
| " Corpuscles | 0.778 | 0.986 |
| Aq. Lipoidal suspension(1) | 0.748 | — |

(1) Containing per 100 cc of $H_2O$, 0.3 gm. of Blood Lipoid prepared by extracting blood corpuscles with ethyl ether and petroleum ether.

## Solubility of Acetylene in Several Organic Solvents at -10°.

(James, 1913.)

| Solvent | Abs. Coef. a | Solvent | Abs. Coef. a |
|---|---|---|---|
| Acetal | 28.8 | Iso Amyl Acetate | 29.3 |
| Acetaldehyde | 60.2 | " " Formate | 17.5 |
| Ethyl Acetate | 44.5 | Methyl Acetate | 52.3 |
| " Formate | 42.2 | Methylal (b. pt. 45.5°) | 54.3 |

Abs. coef a = the volume of gas (reduced to 0° and 760 mm pressure) taken up by one volume of liquid at the given temperature and when the partial pressure of the gas equals 760 mm Hg.

## Solubility of Acetylene in Several Organic Solvents.

| Solvent | t° | Gms. $C_2H_2$ per 100 gms. solvent at 760 mm. | Authority |
|---|---|---|---|
| Benzene | +4 | 0.749 | Garelli, 1925. |
| Nitrobenzene | 3 | 0.573 | " " |
| Dimethyl aniline | 2.1 | 0.746 | " " |
| Cyclohexanol | 2.6 | 0.963 | Cauquil, 1927. |

## Solubility of Acetylene in Several Solvents at Pressures up to Atmospheric.

(Kirijew and Romantchouk, 1938.)

| Solvent | t° | cc $C_2H_2$ (reduced to 0° and 760 mm) per 1 vol. of solvent at: | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | 100 | 200 | 300 | 400 | 500 | 600 | 700 | 760mm Hg |
| Kerosene | -20 | 0.35 | 0.7 | 1.1 | 1.5 | 1.9 | 2.35 | 2.9 | 3.3 |
| " | 0 | 0.2 | 0.5 | 0.8 | 1.05 | 1.3 | 1.6 | 1.9 | 2.05 |
| " | +20 | 0.15 | 0.45 | 0.7 | 0.9 | 1.15 | 1.35 | 1.6 | 1.7 |
| Heavy Oil | 0 | 0.6 | 1.0 | 1.6 | 2.1 | 2.6 | 3.1 | 3.7 | 4.0 |
| Di chlor ethane | 0 | 1.3 | 2.6 | 3.9 | 5.2 | 6.4 | 7.7 | 9.0 | 9.8 |
| Ethyl alcohol | 0 | 1.1 | 2.2 | 3.3 | 4.4 | 5.5 | 6.7 | 7.8 | 8.5 |

## Solubility of Acetylene in Several Solvents.

(Horiuti, 1931.)

| t° | Solubility of $C_2H_2$ in terms of the Ostwald Expression $l$ in: | | | | |
|---|---|---|---|---|---|
| | $CCl_4$ | $(CH_3)_2CO$ | $CH_3COOCH_3$ | $C_6H_6$ | $C_6H_5Cl$ |
| 0 | 3.967 | 38.60 | 38.04 | — | 5.186 |
| 5 | 3.717 | 34.40 | 33.90 | — | 4.772 |
| 10 | 3.482 | 30.68 | 30.13 | 6.184 | 4.399 |
| 15 | 3.278 | 27.33 | 26.80 | 5.661 | 4.082 |
| 20 | 3.102 | 24.47 | 23.82 | 5.202 | 3.800 |
| 25 | 2.932 | 22.00 | 21.25 | 4.816 | 3.540 |
| 30 | 2.778 | 19.80 | 18.97 | 4.449 | 3.316 |
| 40 | 2.499 | 16.19 | 15.03 | 3.849 | 2.930 |
| 50 | — | — | — | — | 2.628 |
| 60 | — | — | — | — | 2.386 |
| 70 | — | — | — | — | 2.180 |

The Ostwald Solubility Expression $l$ is the ratio of the volume (v) of the gas absorbed at any pressure and temperature to the volume (V) of the absorbing liquid, that is $l = \frac{v}{V}$

**TETRA BROMO ETHANE** s $CHBr_2.CHBr_2$.

1000 cc $H_2O$ dissolve 0.651 gm. s $CHBr_2.CHBr_2$ at 30° as determined by interferometer measurement. (Gross, Saylor and Garman, 1933.)

Freezing-points of the system s $CHBr_2.CHBr_2$ + $CH_2Cl.CH_2Cl$ (1.2 dichlor ethane) are given by Timmermans and Mme Vesselovsky, 1931.

**DI CHLORO ETHYLENE** sym. and unsym., CHCl:CHCl, $CH_2CCl_2$.

Freezing-point data are given by Timmermans, 1927, for each of the following systems:

| sym. Dichlor ethylene: | Unsym. Dichlor ethylene |
|---|---|
| + unsym. Dichlor ethylene | + Ethylene bromide |
| + Ethylene bromide | + Ethylene chloride |
| + Ethylene chloride | + 1.2 dibromo ethane |
| + 1.2 dibromo ethane | + 1.2 dichloro ethane |
| + 1.2 dichloro ethane | + 1.1.2.2 tetra chloro ethane |
| + 1.1.2.2 Tetra chloro ethane | |

**TETRA CHLORO ETHANE** s $CHCl_2.CHCl_2$.

100 gms. $H_2O$ dissolve 0.288 gm. $CHCl_2.CHCl_2$ at 25° and 0.336 gm. at 55.6°. (Van Arkel and Vles, 1936.)

Freezing-points are given for mixtures of s tetra chloro ethane and each of the following compounds:

| | | | |
|---|---|---|---|
| 1.2 di bromo ethane | (1) | penta chloro ethane | (1) |
| 1.2 di chloro ethane | (1) | 1.2 di cyan ethane | (1) |
| cis. di chloro ethylene | (2) | succinic acid | (1) |
| trans " " " | (2) | p di chloro benzene | (3) |
| tetra chloro ethylene | (1) | naphthalene | (4) |
| 1.1.2 tri chloro ethane | (1) | | |

(1) Timmermans and Mme. Vesselovsky, 1931; (2) Timmermans, 1927; (3) Timmermans, 1934; (4) Cohen, de Meester and Moesfeld, 1925, 1930.

**ACETYLENE TETRA BROMIDE** $CHBr_2.CHBr_2$.

Freezing-point data are given by Timmermans and Mme. Vesselovsky, 1931, for:

$CHBr_2.CHBr_2$ + $C_2H_4Br_2$
" + $C_2H_2Cl_4$
" + $C_2H_4Cl_2$

## ACETYLIDENE TETRA CHLORIDE $CH_2Cl\ CCl_3$.

SOLUBILITY OF ACETYLIDENE TETRA CHLORIDE IN WATER.
(Van Arkel and Vles, 1936.)

| $t^0$ | Gms. $CH_2Cl\ CCl_3$ per 100 gms. $H_2O$ | Gm. Mol. $CH_2Cl\ CCl_3$ per 100 gms. $H_2O$ |
|---|---|---|
| 0 | 0.120 | 0.00072 |
| 20 | 0.109 | 0.00065 |
| 35 | 0.115 | 0.00069 |
| 50 | 0.125 | 0.00074 |

## DI IODO ETHYLENE CHI:CHI.

Freezing-point data for mixtures of Diiodo Ethylene and Dioxan are given by Rheinboldt and Luyken, 1932.

## ACETYLENE DI IODIDE cis and trans $C_2H_2I_2$.

Results for the freezing-points of these two isomers are given by Chavanne and Vox, 1914.

## KETENE $CH_2CO$.

Freezing-point data for mixtures of ketene and carbazol are given by Pascal, 1914.

## TRI BROMO ACETAMIDE $CBr_3CONH_2$.

Freezing-point data for mixtures of Tri bromo Acetamide and Tri chloro Acetamide are given by Küster, 1891.

## DICHLORO ACETIC ACID $CHCl_2COOH$.

Results for the reciprocal solubility of dichloro acetic acid and water, determined by the freezing-point method are given by Pickering, 1895.

EQUILIBRIUM IN THE SYSTEM DICHLORO ACETIC ACID, BENZENE AND WATER AT 15°.
(Bell, 1930.)

| d. of sat. solution | Gm. Mols. per 1000 gms. sat. sol. $CHCl_2COOH$ | Gm. Mols. per 1000 gms. sat. sol. $H_2O$ | d. of sat. solution | Gm. Mols. per 1000 gms. sat. sol. $CHCl_2COOH$ | Gm. Mols. per 1000 gms. sat. sol. $H_2O$ |
|---|---|---|---|---|---|
| 0.880 | 0.0350 | 0.0408 | 0.895 | 0.179 | 0.130 |
| 0.880 | 0.0710 | 0.0550 | 0.890 | 0.195 | 0.138 |
| 0.883 | 0.123 | 0.101 | | | |

DISTRIBUTION OF DI CHLORACETIC ACID AT 25° BETWEEN : (Smith, 1921-1922.)

Water and Ether.

| Millimols. $CHCl_2COOH$ per liter of $H_2O$ layer ($C_1$). | Millimols. $CHCl_2COOH$ per liter of $CHCl_3$ layer ($C_2$). | $\frac{C_2}{C_1}$. |
|---|---|---|
| 1.25 | 1.025 | 0.82 |
| 2.325 | 2.675 | 1.15 |
| 4.05 | 6.95 | 1.72 |
| 6.5 | 14.8 | 2.28 |
| 9.5 | 25.9 | 2.72 |

Acetone and Glycerol.

| Millimols. $CHCl_2COOH$ per liter of Acetone layer (A). | Millimols. $CHCl_2COOH$ per liter of Glycerol layer (G). | $\frac{A}{G}$. |
|---|---|---|
| 0.830 | 0.43 | 1.93 |
| 2.20 | 0.61 | 3.61 |
| 4.625 | 0.925 | 5.02 |
| 9.725 | 1.375 | 7.07 |
| 17.8 | 1.90 | 19.38 |
| 37.9 | 2.40 | 15.8 |

DISTRIBUTION OF DICHLORO ACETIC ACID AT 25° BETWEEN:

(Kolossowsky, 1934; Kolossowsky and Kulikow, 1934, 1935.)

Water, and Carbon Tetrachloride

| Gm. Equiv. $CHCl_2COOH$ per liter of: $H_2O$ layer ($C_1$) | $CCl_4$ layer ($C_2$) | $\frac{C_1}{C_2}$ |
|---|---|---|
| 0.216 | 0.000853 | 253 |
| 0.462 | 0.00281 | 164 |
| 0.846 | 0.00778 | 109 |
| 1.481 | 0.0178 | 83.2 |
| 2.203 | 0.0289 | 76.2 |
| 4.926 | 0.0628 | 78.4 |
| 6.081 | 0.095 | 64.0 |
| 6.953 | 0.147 | 47.3 |
| 7.881 | 0.452 | 17.4 |
| 5.798 | 2.870 | 2.0 |

Water and Chloroform

| Gm. Equiv. $CHCl_2COOH$ per liter of: $H_2O$ layer ($C_1$) | $CHCl_3$ layer ($C_2$) | $\frac{C_1}{C_2}$ |
|---|---|---|
| 0.054 | 0.006 | 90.0 |
| 0.095 | 0.0025 | 38.0 |
| 0.113 | 0.0044 | 25.7 |
| 0.160 | 0.0070 | 22.9 |
| 0.360 | 0.020 | 18.0 |
| 0.470 | 0.028 | 16.8 |
| 0.670 | 0.046 | 14.6 |
| 1.250 | 0.106 | 11.8 |
| 3.58 | 0.29 | 12.3 |
| 5.86 | 0.74 | 7.9 |

Water and Ethyl Bromide

| Gm. Equiv. $CHCl_2COOH$ per liter of: $H_2O$ layer ($C_1$) | $C_2H_5Br$ layer ($C_2$) | $\frac{C_1}{C_2}$ |
|---|---|---|
| 0.0548 | 0.0095 | 5.77 |
| 0.0726 | 0.0156 | 4.92 |
| 0.344 | 0.093 | 3.70 |
| 0.569 | 0.164 | 3.41 |
| 0.866 | 0.264 | 3.28 |
| 1.520 | 0.480 | 3.7 |
| 2.002 | 0.628 | 3.19 |
| 3.238 | 0.910 | 3.56 |
| 4.681 | 1.343 | 3.49 |

Water and Toluene

| Gm. Equivl $CHCl_2COOH$ per liter of: $H_2O$ layer ($C_1$) | $C_6H_5CH_3$ layer ($C_2$) | $\frac{C_1}{C_2}$ |
|---|---|---|
| 0.0277 | 0.00038 | 72.9 |
| 0.0638 | 0.0014 | 45.6 |
| 0.1121 | 0.0033 | 33.96 |
| 0.2180 | 0.0068 | 26.06 |
| 0.5040 | 0.0295 | 17.08 |
| 1.8270 | 0.1449 | 12.61 |
| 3.1802 | 0.2331 | 13.64 |
| 4.6872 | 0.3314 | 14.14 |
| 6.1866 | 0.5689 | 10.87 |
| 6.3630 | 1.0080 | 6.31 |

Water and Nitro Benzene

| Gm. Equiv. $CHCl_2COOH$ per liter of: $H_2O$ layer ($C_1$) | $C_6H_5NO_2$ layer ($C_2$) | $\frac{C_1}{C_2}$ |
|---|---|---|
| 0.015 | 0.003 | 5.00 |
| 0.051 | 0.015 | 3.40 |
| 0.088 | 0.033 | 2.66 |
| 0.1953 | 0.086 | 2.27 |
| 0.3150 | 0.1688 | 1.87 |
| 0.6363 | 0.4725 | 1.35 |
| 1.0256 | 0.9601 | 1.07 |
| 1.4238 | 1.6632 | 0.86 |
| 1.6959 | 2.2428 | 0.76 |
| 1.9278 | 2.7972 | 0.69 |
| 2.0992 | 3.3264 | 0.63 |

Water and o Nitro Toluene

| Gm. Equiv. $CHCl_2COOH$ per liter of: $H_2O$ layer ($C_1$) | $C_6H_4CH_3NO_2$ layer ($C_2$) | $\frac{C_1}{C_2}$ |
|---|---|---|
| 0.228 | 0.0043 | 5.30 |
| 0.0494 | 0.0106 | 4.66 |
| 0.0976 | 0.0268 | 3.68 |
| 0.1872 | 0.0639 | 2.93 |
| 0.3558 | 0.1577 | 2.24 |
| 0.5827 | 0.3026 | 1.93 |
| 1.039 | 0.721 | 1.44 |
| 1.876 | 1.567 | 1.20 |
| 2.528 | 2.562 | 0.987 |
| 3.469 | 4.148 | 0.836 |
| 4.457 | 4.838 | 0.921 |

### Distribution of Dichloro Acetic Acid Between Water and Olive Oil.

(Bodansky and Meigs, 1932.)

| t° | Gm. Mols. $CHCl_2COOH$ per liter of: $H_2O$ layer ($C_1$) | Olive oil layer ($C_2$) | $\frac{C_1}{C_2}$ |
|---|---|---|---|
| 25 | 0.0440 | 0.0070 | 6.30 |
| " | 0.0822 | 0.0216 | 3.80 |
| 37.5 | 0.0395 | 0.0070 | 5.64 |
| " | 0.0755 | 0.0180 | 4.19 |

### Distribution of Dichloro Acetic Acid at 25° Between Aqueous Magnesium Sulfate Solutions and n Dibutyl Ether.

(Randall and Failey, 1927.)

| d. of aq. $MgSO_4$ solution | Ionic conc. of added $MgSO_4$ | Molality of $CHCl_2COOH$ in Aq. layer | Mol. Fraction of $CHCl_2COOH$ in n dibutyl ether layer |
|---|---|---|---|
| 1.009 | 0.242 | 0.1925 | 0.04606 |
| 1.017 | 0.492 | 0.1952 | 0.04795 |
| 1.029 | 0.970 | 0.1663 | 0.03423 |
| 1.054 | 1.880 | 0.1871 | 0.03883 |

Freezing-point data are given for mixtures of DiChloro Acetic Acid and each of the following compounds:

Azobenzene (1)
Benzoic acid (2)
Chloro acetic acid (2)
Tri chloro acetic acid (2)
Cinnamic acid (2)
Crotonic acid (2)
Dimethyl Pyrone (2)
o, m and p Toluic Acids (2)
α Toluic acid (Phenyl acetic acid) (2)
Urea (3)
Urethan (3)

(1) Kremann and Zechner, 1925; (2) Kendall, 1914; (3) Puschin and Ribovsky, 1932.)

## OXALIC ACID $H_2C_2O_4.2H_2O$.

### Solubility in Water.

(Koppel and Cahn, 1908; for older data see Alluard, Miczynski, 1886; Lamouroux, 1899.)

| t°. | Gms. $H_2C_2O_4$ per 100 Gms. Sat. Sol. | Solid Phase. | t°. | Gms. $H_2C_2O_4$ per 100 Gms. Sat. Sol. | Solid Phase. |
|---|---|---|---|---|---|
| − 0.064 | 0.1805 | Ice | 20 | 8.69 | $H_2C_2O_4.2H_2O$ |
| − 0.152 | 0.452 | " | 30 | 12.46 | " |
| − 0.533 | 1.820 | " | 40 | 17.71 | " |
| − 0.936 | 3.291 | " | 50 | 23.93 | " |
| − 1.50 | 5.836 | " | 60 | 30.71 | " |
| − 0.95 | 3.302 | $H_2C_2O_4.2H_2O$ | 70 | 37.92 | " |
| 0 | 3.416 | " | 80 | 45.80 | " |
| +10 | 5.731 | " | 90.2 | 54.67 | " |

$H_2C_2O_4.2H_2O$ melts in its $H_2O$ of crystallization at 98°.

The following more recent determinations are by Flöttmann, 1928.

| t° | d. of sat. sol. | Gms. $H_2C_2O_4$ per 100 gms. sat. sol. | Solid Phase |
|---|---|---|---|
| 15 | 1.0318 | 6.71 | $H_2C_2O_4.2H_2O$ |
| 20 | 1.0318 | 8.34 | " |
| 25 | 1.0437 | 9.81 | " |

100 cc. sat. sol. of Oxalic acid in water contain 10.4 gms. $H_2C_2O_4$ at 23°.5. } (Schilow and
» » ether » 1.37 » » } Lepin, 1922.)

## Solubility of Oxalic Acid in Aqueous Solutions of Hydrochloric Acid.

(Chapin and Bell, 1931.)

| | Results at 0° | | Results at 50° | | Results at 80° | |
|---|---|---|---|---|---|---|
| d. of sat. sol. | Gms. per 100 gms. sat. solution | | Gms. per 100 gms. sat. solution | | Gms. per 100 gms. sat. solution | |
| | HCl | $H_2C_2O_4$ | HCl | $H_2C_2O_4$ | HCl | $H_2C_2O_4$ |
| 1.0178 | 0.0 | 3.43 | 0.0 | 24.00 | 0.0 | 47.63 |
| — | 0.23 | 3.13 | 1.03 | 21.45 | 1.60 | 44.84 |
| — | 0.55 | 2.86 | 5.17 | 17.17 | 4.77 | 40.77 |
| 1.0190 | 1.25 | 2.45 | 9.13 | 14.06 | 6.33 | 39.37 |
| 1.0278 | 3.67 | 1.87 | 12.17 | 12.38 | 7.86 | 38.44 |
| 1.0356 | 5.15 | 1.65 | 14.63 | 11.47 | 9.27 | 37.70 |
| 1.0518 | 8.51 | 1.34 | 17.10 | 11.02 | 9.87 | 37.80 |
| 1.0690 | 12.01 | 1.13 | 20.16 | 11.08 | 11.18 | 37.91 |
| 1.1083 | 19.67 | 0.97 | 22.61 | 11.76 | 12.51 | 39.34 |
| 1.1428 | 25.72 | 1.05 | 24.91 | 13.20 | 13.66 | 41.22 |
| 1.1796 | 31.57 | 1.73 | 26.38 | 15.07 | 14.67 | 43.74 |

The solid phase was $C_2H_2O_4.2H_2O$ in all cases.

Determinations of the solubility of oxalic acid at room temperature (18-22°) in aqueous hydrochloric acid up to 16.40% concentration are given by Trapp, 1935. The author gives no references to previous determinations.

## Solubility of Oxalic Acid at 25° in Aqueous Solutions of :

(Herz and Neukirch, 1923.)

### Hydrochloric Acid.

| Mols. per liter | | Mols. per liter | |
|---|---|---|---|
| HCl. | $H_2C_2O_4$. | HCl. | $H_2C_2O_4$. |
| 0.708 | 0.884 | 5.098 | 0.424 |
| 0.996 | 0.795 | 5.370 | 0.414 |
| 1.562 | 0.699 | 6.662 | 0.419 |
| 2.247 | 0.605 | 6.820 | 0.423 |
| 3.191 | 0.517 | 7.356 | 0.434 |
| 3.380 | 0.499 | 8.228 | 0.479 |
| 4.476 | 0.441 | 9.170 | 0.568 |

### Nitric Acid

| Mols. per liter | | Mols. per liter | |
|---|---|---|---|
| $HNO_3$. | $H_2C_2O_4$. | $HNO_3$. | $H_2C_2O_4$. |
| 0.00 | 1.181 | 9.654 | 0.495 |
| 1.032 | 0.894 | 9.830 | 0.502 |
| 2.962 | 0.703 | 11.798 | 0.528 |
| 4.676 | 0.605 | 11.778 | 0.537 |
| 5.914 | 0.554 | 14.064 | 0.708 |
| 7.380 | 0.530 | | |

## Solubility of Oxalic Acid in Aqueous HCl and in Aqueous $HNO_3$ at 30°.

(Masson, 1912.)

### In Aq. Hydrochloric Acid.

| G. Mols. HCl per liter Sat. Sol. | $d_{30}$ Sat. Sol. | G. Mols. $(COOH)_2$ per liter Sat. Sol. | Gms. $(COOH)_2$ per liter Sat. Sol. |
|---|---|---|---|
| 0 | 1.0594 | 1.479 | 133.1 |
| 0.503 | 1.0561 | 1.190 | 107.1 |
| 0.970 | 1.0577 | 1.032 | 92.85 |
| 1.939 | 1.0654 | 0.821 | 73.88 |
| 2.959 | 1.0757 | 0.675 | 60.74 |
| 4.528 | 1.0957 | 0.555 | 49.95 |
| 6.026 | 1.1165 | 0.525 | 47.25 |
| 7.907 | 1.1494 | 0.607 | 54.63 |
| 9.680 | 1.1843 | 0.871 | 78.38 |

### In Aq. Nitric Acid.

| G. Mols. $HNO_3$ per liter Sat. Sol. | $d_{30}$ Sat. Sol. | G. Mols. $(COOH)_2$ per liter Sat. Sol. | Gms. $(COOH)_2$ per liter Sat. Sol. |
|---|---|---|---|
| 0.478 | 1.0648 | 1.268 | 114.1 |
| 1.606 | 1.0932 | 1.039 | 93.48 |
| 4.224 | 1.1666 | 0.790 | 71.09 |
| 9.590 | 1.3074 | 0.639 | 57.50 |
| 13.62 | 1.3938 | 0.847 | 76.23 |
| 14.12 | 1.4060 | 0.966 | 86.94 |
| 15.59 | 1.4319 | 1.114 | 100.2 * |
| 16.92 | 1.4443 | 0.840 | 75.6 * |
| 20.84 | 1.4819 | 0.524 | 47.15* |
| 21.63 | 1.4917 | 0.553 | 49.76* |

* The solid phase was $C_2H_2O_2.2H_2O$ in all cases except these solutions in which it was the anhydrous acid, $C_2H_2O_4$.

## Solubility of Oxalic Acid in Aqueous Solutions of Phosphoric Acid.

Results at 18-22° (Trapp, 1935.)

| Gms. per 100 gms. sat. solution | | Gms. per 100 gms. sat. solution | |
|---|---|---|---|
| $H_3PO_4$ | $H_2C_2O_4.2H_2O$ | $H_3PO_4$ | $H_2C_2O_4.2H_2O$ |
| 0.0 | 11.20 | 15.10 | 6.05 |
| 3.06 | 12.06 | 18.48 | 5.65 |
| 3.91 | 10.77 | 21.58 | 5.24 |
| 6.48 | 9.40 | 24.80 | 3.72 |
| 9.00 | 9.86 | 26.01 | 4.75 |
| 10.39 | 8.86 | 28.92 | 3.49 |
| 11.81 | 8.10 | 28.93 | 3.17 |
| 12.03 | 6.97 | 29.35 | 2.95 |
| 14.51 | 7.04 | | |

Results at 25° (Walton and Kepfer, 1930.)

| Gm. Equiv. per liter | |
|---|---|
| $H_3PO_4$ | $C_2H_2O_4$ |
| 0.0 | 2.412 |
| 3.14 | 2.020 |
| 8.85 | 1.383 |
| 13.36 | 1.025 |
| 19.51 | 0.699 |
| 24.98 | 0.571 |
| 30.55 | 0.575 |
| 35.44 | 0.768 |
| 38.62 | 1.121 |
| 40.15 | 1.504 |

## Solubility of Oxalic Acid in Aqueous Solutions of Phosphorus Acid at 25°.

(Redfield and King, 1936.)

| Normality of Aq. $H_3PO_3$ solutions | Normality of dissolved $(COOH)_2$ | Normality of Aq. $H_3PO_3$ solutions | Normality of dissolved $(COOH)_2$ |
|---|---|---|---|
| 0.0 | 2.407 | 23.39 | 1.00 |
| 8.48 | 1.71 | 30.77 | 0.77 |
| 12.78 | 1.51 | 36.66 | 0.71 |
| 15.11 | 1.38 | 42.02 | 0.81 |
| 18.38 | 1.21 | 44.73 | 0.84 |
| 20.21 | 1.13 | | |

## Solubility of Oxalic Acid at 25° in Aqueous Solutions of Sulfuric Acid.

(Average results of Knox and Richards, 1919, and Herz and Neukirch, 1923.)

| Equiv. Normalities | | Equiv. Normalities | | Equiv. Normalities. | |
|---|---|---|---|---|---|
| $H_2SO_4$. | $H_2C_2O_4$. | $H_2SO_4$. | $H_2C_2O_4$. | $H_2SO_4$. | $H_2C_2O_4$. |
| 0.0 | 2.38 | 6.0 | 0.85 | 12.0 | 0.69 |
| 1.0 | 1.90 | 7.0 | 0.76 | 13.0 | 0.76 |
| 2.0 | 1.54 | 8.0 | 0.70 | 14.0 | 0.87 |
| 3.0 | 1.31 | 9.0 | 0.66 | 15.0 | 1.00 |
| 4.0 | 1.11 | 10.0 | 0.65 | 16.0 | 1.30 |
| 5.0 | 0.97 | 11.0 | 0.66 | 17.0 | 1.80 |

## Solubility of Oxalic Acid in Aqueous Solutions of $H_2SO_4$ at 25°. (Wirth, '08.)

| Conc. of Aq. $H_2SO_4$ Normality. | $d_{25}$ of Sat. Sol. | Gms. per 100 Gms. Sat. Sol. | | Conc. of Aq. $H_2SO_4$ Normality. | $d_{25}$ of Sat. Sol. | Gms. per 100 Gms. Sat. Sol. | |
|---|---|---|---|---|---|---|---|
| | | $SO_3$. | $(COOH)_2$. | | | $SO_3$. | $(COOH)_2$. |
| 0 | 1.047 | 0 | 10.23 | 4.85 | 1.157 | 14 | 3.92 |
| 1 | 1.064 | 2.98 | 8.03 | 5.67 | 1.177 | 16.44 | 3.51 |
| 2.39 | 1.140 | 7.30 | 6.02 | 6.45 | 1.220 | 17.84 | 3.12 |
| 4.36 | 1.146 | 12.57 | 4.26 | 8.9 | 1.280 | 25.92 | 2.37 |

Additional determinations of the solubility of oxalic acid at 18-22° in aqueous solutions of sulfuric acid up to 47 wt. % $H_2SO_4$, are given by Trapp, 1935.

## Solubility of Oxalic Acid at 25° in Aqueous Solutions of :

(Knox and Richards, 1919.)

| Acetic Acid. Equiv. Normalities. | | Formic Acid Equiv. Normalities. | | Lactic Acid. Equiv. Normalities. | |
|---|---|---|---|---|---|
| $CH_3COOH$. | $H_2C_2O_4$. | HCOOH. | $H_2C_2O_4$. | $CH_3CHOHCOOH$. | $H_2C_2O_4$. |
| 0.135 | 2.356 | 0.097 | 2.382 | 0.0 | 2.409 |
| 0.321 | 2.361 | 0.437 | 2.385 | 1.337 | 2.228 |
| 0.923 | 2.395 | 0.967 | 2.411 | 2.718 | 2.054 |
| 1.361 | 2.402 | 1.287 | 2.414 | 4.051 | 1.856 |
| 1.844 | 2.401 | 1.825 | 2.441 | 5.357 | 1.633 |
| 3.563 | 2.351 | 2.678 | 2.430 | 6.477 | 1.412 |
| 5.721 | 2.168 | 5.360 | 2.326 | 7.647 | 1.171 |
| 8.005 | 1.839 | 8.13 | 2.131 | 8.709 | 0.938 |
| 9.864 | 1.546 | 11.00 | 1.868 | 9.52 | 0.832 |
| 12.55 | 1.100 | 12.17 | 1.758 | | |
| 14.03 | 0.896 | 16.63 | 1.496 | | |
| 14.21 | 0.875 | 19.25 | 1.568 | | |
| 14.83 | 0.802 | 21.11 | 2.339 | | |

## Solubility of Oxalic Acid in Aqueous Salt Solutions at 25°.

(Herz and Hiebenthal, 1928; 1929.)

Results for aqueous solutions of:

| Potassium Chloride | | Ammonium Chloride | | Sodium Chloride | |
|---|---|---|---|---|---|
| Gms. per liter | | Gms. per liter | | Gms. per liter | |
| KCl | $C_2H_2O_4.2H_2O$ | $NH_4Cl$ | $C_2H_2O_4.2H_2O$ | NaCl | $C_2H_2O_4.2H_2O$ |
| 0.0 | 155 | 25 | 158 | 25.7 | 156 |
| 30 | 158 | 65 | 179 | 62.6 | 164 |
| 53 | 137 | 78 | 151 | 108.7 | 179 |
| 72 | 122 | 128 | 131 | 140.3 | 195 |
| 114 | 72 | 188 | 94 | 201.7 | 213 |
| 175 | 75 | 213 | 87 | 239.7 | 186 |
| 315 | 68* | 304 | 88* | 304 | 174* |

* Solid Phase $C_2H_2O_4.2H_2O$ + KCl, + $NH_4Cl$ or + NaCl.

## Solubility of Oxalic Acid in Aqueous Solutions of Dioxane at 25°.

(Herz and Lorentz, 1929.)

| cc $C_4H_8O_2$ (m or p?) per 100 cc Aq. solvent | Gm. Equiv. $(COOH)_2$ per liter | cc $C_4H_8O_2$ (m or p?) per 100 cc Aq. solvent | Gm. Equiv. $(COOH)_2$ per liter |
|---|---|---|---|
| 10 | 1.30 | 80 | 2.26 |
| 30 | 1.66 | 90 | 2.29 |
| 50 | 1.97 | 100 | 1.33 |
| 75 | 2.19 | | |

### Solubility of Oxalic Acid in Several Alcohols.
(Timofeiew, 1894.)

| Alcohol. | t°. | Gms. $(COOH)_2$ per 100 Gms. Sat. Sol. | Alcohol. | t°. | Gms. $(COOH)_2$ per 100 Gms. Sat. Sol. |
|---|---|---|---|---|---|
| Methyl Alcohol | − 1.5 | 34.2 | Propyl Alcohol | − 1.5 | 12.2 |
| " " | +20.2 | 39.8 | " " | +18.5 | 16.7 |
| Ethyl Alcohol | − 1.5 | 22.4 | " " | 20.2 | 17.5 |
| " " | +18.5 | 26.2 | Isobutyl Alcohol | 20.2 | 10.9 |
| " " | 20.2 | 26.9 | | | |

### Solubility of Oxalic Acid in Absolute and in Aqueous Ether at 25°.
(Bödtker, 1897; Bourgoin.)

100 gms. absolute ether dissolve 1.47 gms. $(COOH)_2.2H_2O$.
100 gms. absolute ether dissolve 23.59 gms. $(COOH)_2$.

In Aqueous Ether Solutions.

| Gms. Solid Acid Added per 100 cc. Ether Solution. | | Gms. per 100 cc. Ether Solution. | |
|---|---|---|---|
| $(COOH)_2.2H_2O$. | $(COOH)_2$. | $H_2O$. | $(COOH)_2$. |
| (1) 5 | 0 | 1.250 | 0.742 |
| (2) 5 | 0 | 0.788 | 0.720 |
| 5 | 0 | 0.418 | 1.044 |
| 5 | 2.44 | 0.360 | 3.388 |
| 5 | 4.82 | 0.484 | 6.038 |
| 5 | 7.14 | 0.558 | 8.538 |
| 5 | 9.42 | 0.632 | 10.996 |
| 5 | 11.63 | 0.676 | 13.316 |
| 5 | 13.79 | 0.760 | 15.684 |
| 5 | 18.18 | 0.816 | 17.818 |
| 5 | 22.73 | 0.816 | 17.818 |

(1) Ether saturated with water. (2) Ether containing 0.694 per cent water.

100 gms. glycerol dissolve 15 gms. oxalic acid at 15.5°. (Ossendowski, 1907.)
100 gms. 95% formic acid dissolve 9.74 gms. anhydrous oxalic acid at 16.8°. (Aschan, 1913.)

### Distribution of Oxalic Acid Between Water and Ether :

At 19° (Schilow and Lepin, 1922.)

| Gms. $H_2C_2O_4$ per 100 cc. | |
|---|---|
| $H_2O$ layer. | $(C_2H_5)_2O$ layer. |
| 0.594 | 0.0322 |
| 1.298 | 0.0792 |
| 2.600 | 0.1830 |
| 4.970 | 0.4140 |
| 10.50 | 1.06* |

* Solid Phase present.

At 25° (Smith, 1921, 1922.)

| Millimols $H_2C_2O_4$ per liter. | | |
|---|---|---|
| $H_2O$ layer $(C_1)$. | $(C_2H_5)_2O$ layer $C_2$. | $\frac{C_2}{C_1}$. |
| 5.9375 | 0.525 | 0.0885 |
| 14.10 | 1.31 | 0.0930 |
| 22.625 | 2.0375 | 0.0902 |
| 39.35 | 3.80 | 0.0965 |
| 84.25 | 9.60 | 0.113 |

### Distribution of Oxalic Acid between Water and Amyl Alcohol at 20°.
(Herz and Fischer, 1904.)

| Millimols ½ $(COOH)_2$ per 10 cc. | | Gms. $(COOH)_2$ per 100 cc. | |
|---|---|---|---|
| Aq. Layer. | Alcoholic Layer. | Aq. Layer. | Alcoholic Layer. |
| 0.6806 | 0.1451 | 0.306 | 0.0653 |
| 2.364 | 0.7233 | 1.064 | 0.326 |
| 6.699 | 2.550 | 3.015 | 1.148 |
| 10.029 | 4.300 | 4.511 | 1.934 |

Data for the distribution of oxalic acid between mixtures of amyl alcohol + ether and water at 25° are given by Herz and Kurzer (1910).

### Distribution of Oxalic Acid between Water and Ether.
(Pinnow, 1915.)

| Results at 15°. Gm. Mols. $(COOH)_2$ per Liter. | | Dist. Coef. of: | | Results at 27°. Gm. Mols. $(COOH)_2$ per Liter. | | Dist. Coef. of: | |
|---|---|---|---|---|---|---|---|
| Water Layer. | Ether Layer. | Total Acid. | Undissoc. Acid. | Water Layer. | Ether Layer. | Total Acid. | Undissoc. Acid. |
| 0.3435 | 0.02945 | 11.6 | 8.49 | 0.760 | 0.0637 | 11.9 | 8.18 |
| 0.1885 | 0.01395 | 13.5 | 8.81 | 0.561 | 0.0433 | 13 | 8.37 |
| 0.124 | 0.00845 | 14.8 | 8.69 | 0.3575 | 0.0250 | 14.3 | 8.26 |
| 0.0892 | 0.00553 | 16.1 | 8.72 | 0.2550 | 0.0165 | 15.5 | 8.12 |
| 0.0470 | 0.00248 | 19 | 8.19 | 0.1754 | 0.01025 | 17.1 | 7.94 |
| 0.0435 | 0.0022 | 19.8 | 8.26 | | | | |

Data for the effect of $H_2SO_4$ upon the above distribution are also given.
Data similar to the above for a greater range of conc. at 25° are given by Chandler (1908).

## VINYL CHLORIDE $CH_2CHCl$.

### Solubility of Vinyl Chloride in Several Solvents at Pressures up to Atmospheric.
(Kirijew and Romantchouk, 1936.)

| Solvent | t° | cc $C_2H_3Cl$ (reduced to 0° and 760 mm) per 1 volume of solvent at: 100 | 200 | 300 | 400 | 500 | 600 | 700 | 760 mm Hg. |
|---|---|---|---|---|---|---|---|---|---|
| Kerosene | −20 | 37 | 77 | 125 | — | — | — | — | — |
| " | 0 | 8 | 18 | 29 | 43 | 62 | 85 | 110 | 125 |
| " | +20 | 4.5 | 9 | 13.5 | 19 | 25 | 31 | 37 | 40 |
| Heavy Oil | 0 | 13 | 28 | 48 | 64 | — | — | — | — |
| Dichlor Ethane | 0 | 24 | 48 | 76 | 106 | — | — | — | — |
| Ethyl Alchol | 0 | 10 | 22 | 33 | 47 | — | — | — | — |
| Oil of ——— | 0 | 8 | 16 | 24 | 33 | 44 | 60 | — | — |

## TRI CHLORO ETHANES α Ethylene Tri-Chloride $CH_3CCl_3$.
β Vinyl Trichloride $CH_2ClCHCl_2$.

### Solubility of Each Separately in Water.
(Van Arkel and Vles, 1936.)

| Results for α Ethylene Trichloride | | | Results for β Vinyl Trichloride | | |
|---|---|---|---|---|---|
| t° | Gms. $CH_3CCl_3$ per 100 gms. $H_2O$ | Gm. Mols. $CH_3CCl_3$ per 100 gms. $H_2O$ | t° | Gms. $CH_2ClCHCl_2$ per 100 gms. $H_2O$ | Gm. Mols. $CH_2ClCHCl_2$ per 100 gms. $H_2O$ |
| 0 | 0.159 | 0.00119 | 0 | 0.466 | 0.00350 |
| 20 | 0.132 | 0.00099 | 20 | 0.436 | 0.00327 |
| 35 | 0.126 | 0.00094 | 35 | 0.458 | 0.00344 |
| 50 | 0.128 | 0.00096 | 55 | 0.532 | 0.00399 |

Freezing-point data are given by Timmermans and Mme. Vesslovsky, 1931, for:

β Vinyl Trichloride + 1.2 Dichloro Ethane
" " + 1.1.22 Tetra chloro Ethane

## ACETONITRILE $CH_3CN$.

The upper critical solution temperature of a mixture of acetonitrile and water ($H_2O$) containing 62 percent $CH_3CN$ is -0.9°.

The upper critical solution temperature of a mixture of acetonitrile and heavy water ($D_2O$) containing 62.05 percent $CH_3CN$ is +5.1°.

(Timmermans and Poppe, 1935.)

### The Critical Solution Temperatures of Mixtures of Acetonitrile and Water.

(Ewert, 1937.)

| Critical Solution Temperature | Gm. Mols. $CH_3CN$ per 100 gm. mols. sat. Solution | Critical Solution Temperature | Gm. Mols. $CH_3CN$ per 100 gm. mols. sat. Solution |
|---|---|---|---|
| -8.9 | 16.3 | -1.2 | 43.3 |
| -4.0 | 18.9 | -4.8 | 57.9 |
| -1.8 | 26.6 | -4.8 | 58.3 |
| -0.9 | 32.9 | | |

### The Freezing-points of Mixtures of Acetonitrile and Water.

(Ewert, 1937.)

| t° | Gm. Mols. $CH_3CN$ per 100 gm. mols. mixture | t° | Gm. Mols. $CH_3CN$ per 100 gm. mols. mixture |
|---|---|---|---|
| -4.2 | 10.0 | -45.8(Eutectic) | |
| -9.0 | 14.5 | -12.7 | 70.0 |
| -9.2 | 14.6 | -13.3 | 79.2 |
| -13.2 | 16.3 | -21.4 | 86.0 |
| -13.2 | 51.3 | -45.2 | 100.0 |

The critical solution temperature of the system Acetonitrile and 2.2.4 Tri methyl Pentane (i Octane) is 81°. That for the system acetonitrile and n Heptane is 84°. (Cornish, Archibald, Murphy and Evans, 1934.)

Freezing-point data are given by Joukovsky, 1934 for mixtures of Acetonitrile and each of the following compounds: Proprionitrile, Butyronitrile, Valeronitrile, Benzene, Nitrobenzene and Formic Acid. This author also gives results for the total and partial vapor pressures of mixtures of acetonitrile and ether, and acetonitrile and methyl alcohol.

## METHYL THIOCYANATE $CH_3SCN$.

Complete data for the T, r diagram of the pseudo binary system methyl thiocyanate (m. pt. — 53°.58) + methyl isothiocyanate ($CH_3NCS$) m. pt. + 35°.93 are given by Gillis, 1918. A single eutectic at — 64.4° was found. The author also gives data for the curve of fusion of methyl iso thiocyanate + trimethyl tri thiocyanate $(CH_3SCN)_3$. A single eutectic at 34.9° was found. The boiling-point curve for $CH_3SCN + CH_3NCS$ is also given.

## BromACETIC ACID $CH_2.Br.COOH$.

DISTRIBUTION OF BROMACETIC ACID AT 25° BETWEEN: (Smith, 1921-1922.)

### Water and Chloroform.

| Millimols. $CH_2BrCOOH$ per liter of | | $\frac{C_2}{C_1}$. |
|---|---|---|
| $H_2O$ layer ($C_1$) | $CHCl_3$ layer ($C_2$). | |
| 9.40 | 0.45 | 0.0478 |
| 14.45 | 0.75 | 0.0519 |
| 18.45 | 1.05 | 0.0570 |
| 32.00 | 2.08 | 0.065 |

### Water and Ether.

| Millimols. $CH_2BrCOOH$ per liter of | | $\frac{C_2}{C_1}$. |
|---|---|---|
| $H_2O$ layer ($C_1$). | $(C_2H_5)_2O$ layer ($C_2$). | |
| 0.9625 | 1.3375 | 1.390 |
| 1.3125 | 1.8875 | 1.438 |
| 1.475 | 3.475 | 1.760 |
| 3.05 | 6.30 | 2.063 |
| 4.25 | 9.55 | 2.245 |

### Water and Xylene.

| Millimols. $CH_2BrCOOH$ per liter of | | $\frac{C_2}{C_1}$. |
|---|---|---|
| $H_2O$ layer ($C_1$). | Xylene layer ($C_2$). | |
| 23.30 | 0.70 | 0.0300 |
| 26.70 | 0.90 | 0.0337 |
| 37.40 | 1.15 | 0.0325 |

### Acetone and Glycerol.

| Millimols. $CH_2BrCOOH$ per liter of | | $\frac{A}{G}$. |
|---|---|---|
| Acetone layer (A). | Glycerol layer (G) | |
| 2.00 | 0.645 | 3.10 |
| 4.70 | 1.60 | 2.94 |
| 7.25 | 2.25 | 3.22 |
| 14.20 | 4.35 | 3.26 |

DISTRIBUTION OF BROM ACETIC ACID AT 25° BETWEEN:
(Smith and White, 1929.)

### Water and Benzene

| Millimols $CH_2BrCOOH$ per liter of | | Millimols $CH_2BrCOOH$ per liter of | |
|---|---|---|---|
| $H_2O$ layer | $C_6H_6$ layer | $H_2O$ layer | $C_6H_6$ layer |
| 13.39 | 0.35 | 37.99 | 1.06 |
| 17.76 | 0.48 | 42.41 | 1.19 |
| 24.21 | 0.65 | 62.25 | 1.88 |
| 30.58 | 0.82 | 91.85 | 2.78 |

### Water and Toluene

| Millimols $CH_2BrCOOH$ per liter of | | Millimols $CH_2BrCOOH$ per liter of | |
|---|---|---|---|
| $H_2O$ layer | $C_6H_5CH_3$ layer | $H_2O$ layer | $C_6H_5CH_3$ layer |
| 13.56 | 0.260 | 38.49 | 0.805 |
| 17.95 | 0.358 | 42.85 | 0.970 |
| 24.43 | 0.535 | 63.15 | 1.43 |
| 30.90 | 0.660 | 92.90 | 2.25 |

DISTRIBUTION OF BROMO ACETIC ACID BETWEEN WATER AND OLIVE OIL.
(Bodansky and Meigs, 1932.)

| t° | Gm. Mols. $CH_2BrCOOH$ per liter of: | | $\frac{C_1}{C_2}$ |
|---|---|---|---|
| | $H_2O$ layer ($C_1$) | Olive Oil layer $C_2$ | |
| 25 | 0.0878 | 0.0114 | 7.70 |
| " | 0.1690 | 0.0300 | 5.63 |
| 37.5 | 0.0938 | 0.0060 | 15.60 |
| " | 0.1780 | 0.0220 | 8.10 |

## BROMAL HYDRATE $CBr_3CH(OH)_2$.

### Equilibrium in the System Bromal-Water. (Efremov, 1918.)

The sealed tube method was used. The tubes were constantly shaken and the rate of change of temperature during the observation of the disappearance of the last crystal was not more than 0°.1 to 0°.2 per hour. The temperature of the separation of the liquid into two layers was very sharp and the interval between separation and unification was only 0.2°.

The original results were plotted and the following values read from the curves.

| t° of Crystallization or melting. | t° of separation into 2 layers. | Gms. $CBr_3COH$ per 100 gms. sat. sol. | Solid Phase. | t° of Crystallization or melting. | t° of separation into 2 layers. | Gms. $CBr_3COH$ per 100 gms. sat. sol. | Solid Phase. |
|---|---|---|---|---|---|---|---|
| — 1.0 | – | 2.5 | Ice | 40.0 | 107.2 | 76.0 | $CBr_3CH(OH)_2$ |
| — 1.5 | – | 5.0 | » | 45.0 | 107.0 | 85.0 | » |
| — 2.0 | – | 7.0 | » | 47.0 | 106.8 | 88.2 | » |
| — 2.6 (Eutec.) | – | 11.3 | » + $CBr_3CH(OH)_2$ | 48.0 | 106.5 | 90.0 | » |
| — 1.5 | – | 12.5 | $CBr_3CH(OH)_2$ | 49.0 | 106.0 | 92.0 | » |
| 0.0 | – | 14.5 | » | 49.7 | 107.4 | 94.0 | » |
| + 5.0 | – | 21.5 | » | 49.0 | 106.9 | 94.5 | » |
| 10.0 | – | 29.5 | » | 47.0 | 103.5 | 95.9 | » |
| 20.0 | – | 44.5 | » | 45.0 | 99.0 | 96.5 | » |
| 25.0 | 110.2 | 52.0 | » | 40.0 | 85.0 | 98.0 | » |
| 30.0 | 109.6 | 60.0 | » | 30.0 | 69.0 | 98.7 | » |
| 35.0 | 108.2 | 67.5 | » | 20.0 | 57.0 | 99.2 | » |

The author also gives data for the density and viscosity of mixtures of bromal and water at different temperatures.

The distributior coefficient of bromal hydrate between olive oil and water is 0.665 at ord. temp. (Baum, 1899); 0.7 at ord. temp. (Meyer, 1909).

## CHLORO ACETIC ACID

### Solubility of the α, β, and γ Modification of Monochloroacetic Acid in Water at Different Temperatures.

(Miers and Isaac, 1908; Pickering, 1895)

The determinations were made by the sealed tube method. The following figures were obtained by plotting the original results on cross-section paper:

| t°. | Gms. per 100 Gms. of Each Sat. Solution. α Modification. | β Modification. | γ Modification. | t°. | Gms. per 100 Gms. of Each Sat. Solution. α Modification. | β Modification. | γ Modification. |
|---|---|---|---|---|---|---|---|
| 20 | ... | ... | 88.0 | 50 | 95.0 | 97.0 | 99.6 |
| 25 | ... | 85.8 | 90.0 | 51 (m. pt.) | ... | ... | 100.0 |
| 30 | 86.0 | 88.2 | 92.2 | 55 | 97.2 | 99.3 | ... |
| 35 | 88.4 | 90.6 | 94.1 | 56.5 (m. pt.) | ... | 100.0 | ... |
| 40 | 90.8 | 93.0 | 95.8 | 60 | 99.0 | ... | ... |
| 45 | 93.0 | 95.0 | 97.8 | 62.4 (m. pt.) | 100.0 | ... | ... |

Results for the reciprocal solubilities of chloro acetic acid and water, determined by the freezing-point method, are given by Pickering, 1895.

## Equilibrium in the System Chloro Acetic Acid, Benzene and and Water at 15°.

(Bell, 1930.)

| d. of sat. sol. | Gm. Mols. per 1000 gms. sat. solution $CH_2ClCOOH$ | $H_2O$ | d. of sat. sol. | Gm. Mol. per 1000 gms. sat. solution $CH_2ClCOOH$ | $H_2O$ |
|---|---|---|---|---|---|
| 0.884 | 0.0620 | 0.0329 | 0.888 | 0.284 | 0.0776 |
| 0.881 | 0.115 | 0.0423 | 0.886 | 0.325 | 0.0828 |
| 0.880 | 0.174 | 0.0574 | 0.892 | 0.404 | 0.1000 |
| 0.885 | 0.217 | 0.0645 | | | |

## Distribution of Chloracetic Acid between:

(Herz and Lewy.)

### Water and Chloroform at 25°.

| Gms. $CH_2ClCOOH$ per 100 cc. $H_2O$ Layer. | Gms. $CH_2ClCOOH$ per 100 cc. $CHCl_3$ Layer. | G. M. $CH_2ClCOOH$ per 100 cc. $H_2O$ Layer. | G. M. $CH_2ClCOOH$ per 100 cc. $CHCl_3$ Layer. |
|---|---|---|---|
| 5* | 0.283 | 0.05 | 0.0025 |
| 10 | 0.614 | 0.10 | 0.0060 |
| 20 | 1.088 | 0.20 | 0.0135 |
| 40 | 2.948 | 0.40 | 0.029 |
| 50 | 3.684 | 0.60 | 0.045 |
| 60 | 4.440 | 0.70 | 0.061 |
| 70 | 7.086 | 0.75 | 0.077 |

### Water and Bromoform at 25°.

| Gms. $CH_2ClCOOH$ per 100 cc. $H_2O$ Layer. | Gms. $CH_2ClCOOH$ per 100 cc. $CHBr_3$ Layer. | G. M. $CH_2ClCOOH$ per 100 cc. $H_2O$ Layer. | G. M. $CH_2ClCOOH$ per 100 cc. $CHBr_3$ Layer. |
|---|---|---|---|
| 40* | 0.850 | 0.45 | 0.011 |
| 50 | 1.889 | 0.50 | 0.0165 |
| 60 | 2.994 | 0.60 | 0.028 |
| 70 | 4.241 | 0.70 | 0.040 |
| 80 | 5.620 | 0.80 | 0.053 |
| 90 | 7.560 | 0.90 | 0.067 |
| 91.6 | 11.340 | 0.97 | 0.120 |

## Distribution of Chloracetic Acid between:

(Herz and Lewy.)

### Water and Carbon Disulphide at 25°.

| Gms. $CH_2ClCOOH$ per 100 cc. $H_2O$ Layer. | Gms. $CH_2ClCOOH$ per 100 cc. $CS_2$ Layer. | G. M. $CH_2ClCOOH$ per 100 cc. $H_2O$ Layer. | G. M. $CH_2ClCOOH$ per 100 cc. $CS_2$ Layer. |
|---|---|---|---|
| 60* | 0.426 | 0.6 | 0.0042 |
| 80 | 0.691 | 0.8 | 0.007 |
| 90 | 0.803 | 1.0 | 0.009 |
| 100 | 1.040 | 1.05 | 0.0105 |
| 105 | 1.464 | 1.10 | 0.015 |
| 106.7 | 1.890 | 1.13 | 0.020 |

### Water and Carbon Tetrachloride at 25°.

| Gms. $CH_2ClCOOH$ per 100 cc. $H_2O$ Layer. | Gms. $CH_2ClCOOH$ per 100 cc. $CCl_4$ Layer. | G. M. $CH_2ClCOOH$ per 100 cc. $H_2O$ Layer. | G. M. $CH_2ClCOOH$ per 100 cc. $CCl_4$ Layer. |
|---|---|---|---|
| 90* | 1.417 | 0.95 | 0.0150 |
| 95 | 2.031 | 1.00 | 0.0195 |
| 100 | 2.645 | 1.05 | 0.0270 |
| 105 | 4.26 | 1.10 | 0.0415 |
| 106.7 | 5.19 | 1.13 | 0.0550 |

* See Note, page 106

Results showing the influence of sulfuric acid upon the distribution of monochloroacetic acid between water and ethyl ether at 26° are given by Hantzsch and Vagt (1901).

## Distribution of Chloracetic Acid between:

(Herz and Fischer.)

| Water and Benzene at 25°. | | | | Water and Toluene at 25°. | | | |
|---|---|---|---|---|---|---|---|
| Gms. $CH_2ClCOOH$ per 100 cc. | | G. M. $CH_2ClCOOH$ per 100 cc. | | Gms. $CH_2ClCOOH$ per 100 cc. | | G. M. $CH_2ClCOOH$ per 100 cc. | |
| $H_2O$ Layer. | $C_6H_6$ Layer. | $H_2O$ Layer. | $C_6H_6$ Layer. | $H_2O$ Layer. | $C_6H_5CH_3$ Layer. | $H_2O$ Layer. | $C_6H_5CH_3$ Layer. |
| 0.25* | 8.69 | 0.0025 | 0.090 | 0.1* | 5.22 | 0.001 | 0.055 |
| 0.5 | 15.59 | 0.005 | 0.155 | 0.5 | 20.31 | 0.005 | 0.20 |
| 1.0 | 27.87 | 0.010 | 0.28 | 1.0 | 34.87 | 0.010 | 0.36 |
| 1.5 | 41.10 | 0.015 | 0.415 | 1.5 | 49.14 | 0.015 | 0.50 |
| 2.0 | 52.90 | 0.02 | 0.54 | 2.0 | 60.46 | 0.02 | 0.62 |
| 3.0 | 68.01 | 0.03 | 0.70 | 3.0 | 72.28 | 0.03 | 0.77 |
| 4.0 | 76.52 | 0.04 | 0.79 | 4.0 | 81.72 | 0.04 | 0.85 |
| | | | | 5.0 | 86.94 | 0.05 | 0.90 |

* See Note, page 106

Additional data for the distribution of monochloroacetic acid between water and benzene as well as similar results for dichloroacetic acid are given by Georgievics, 1915.

## Distribution of Mono Chloracetic Acid Between Water and Ether at :

18° (Schreiner, 1922.) 25° (Smith, 1921-1922.)

| Concentration of $CH_2ClCOOH$ in | | Concentration of $CH_2ClCOOH$ in | | Millimols. $CH_2ClCOOH$ per liter in | | |
|---|---|---|---|---|---|---|
| $H_2O$ layer. | Ether layer. | $H_2O$ layer. | Ether layer. | $H_2O$ layer ($C_1$). | Ether layer ($C_2$). | $\frac{C_2}{C_1}$. |
| 0.0103 | 0.0206 | 0.0761 | 0.181 | 1.40 | 1.55 | 1.08 |
| 0.0165 | 0.0348 | 0.150 | 0.390 | 2.85 | 3.70 | 1.299 |
| 0.0260 | 0.0571 | 0.169 | 0.452 | 5.11 | 8.48 | 1.66 |
| 0.0320 | 0.0760 | 0.290 | 0.795 | 7.80 | 13.40 | 1.718 |
| 0.0492 | 0.118 | 0.430 | 1.200 | 8.58 | 15.20 | 1.770 |

Schreiner also gives results for the distribution in presence of sodium monochlor acetate.

## Distribution of Mono Chloracetic Acid at 23° Between : (Smith, 1921-1922.)

| Water and Chloroform. | | | Acetone and Glycerol. | | |
|---|---|---|---|---|---|
| Millimols. $CH_2ClCOOH$ per liter of | | | Millimols. $CH_2ClCOOH$ per liter in | | |
| $H_2O$ layer ($C_1$). | $CHCl_3$ layer ($C_2$). | $\frac{C_2}{C_1}$. | Acetone layer (A). | Glycerol layer (G). | $\frac{A}{G}$. |
| 42.75 | 0.625 | 0.0146 | 1.30 | 0.325 | 4.00 |
| 68.25 | 1.250 | 0,0183 | 3.90 | 0.975 | 4.00 |
| 86.50 | 1.6875 | 0.0195 | 8.60 | 2.00 | 4.30 |
| 199 00 | 5.50 | 0.0276 | 15.925 | 3.125 | 4.60 |
| 194.25 | 5.50 | 0.0283 | 29.25 | 6.15 | 4.76 |

## Distribution of Chloro Acetic Acid at 25° Between:

(Kolossowsky, 1934; Kolossowsky and Kulikow, 1934, 1935.)

### Water and Carbon Tetrachloride

| Gm. Equiv. $CH_2ClCOOH$ per liter of: $H_2O$ layer ($C_1$) | $CCl_4$ layer ($C_2$) | $\frac{C_1}{C_2}$ |
|---|---|---|
| 0.2588 | 0.000748 | 346 |
| 0.525 | 0.00225 | 233 |
| 1.033 | 0.00549 | 188 |
| 1.523 | 0.00935 | 163 |
| 2.432 | 0.0163 | 149 |
| 3.854 | 0.0264 | 146 |
| 5.524 | 0.0445 | 124 |
| 7.082 | 0.073 | 97 |
| 9.098 | 0.206 | 44.2 |
| 9.813 | 0.437 | 22.5 |
| 10.029 | 0.0605 | 16.6 |

### Water and Chloroform

| Gm. Equiv. $CH_2ClCOOH$ per liter of: $H_2O$ layer ($C_1$) | $CHCl_3$ layer ($C_2$) | $\frac{C_1}{C_2}$ |
|---|---|---|
| 0.1302 | 0.0034 | 38.3 |
| 0.2047 | 0.0072 | 28.4 |
| 0.3200 | 0.0130 | 24.6 |
| 0.5587 | 0.0258 | 21.7 |
| 1.1340 | 0.0661 | 17.2 |
| 1.8300 | 0.1300 | 14.1 |
| 2.410 | 0.1660 | 14.5 |
| 2.9250 | 0.2106 | 13.9 |
| 4.3275 | 0.3018 | 14.3 |
| 6.6141 | 0.4777 | 13.8 |
| 8.1900 | 1.1000 | 7.44 |
| 8.2678 | 1.6875 | 4.90 |

### Water and Ethyl Bromide

| Gm. Equiv. $CH_2ClCOOH$ per liter of: $H_2O$ layer ($C_1$) | $C_2H_5Br$ layer ($C_2$) | $\frac{C_1}{C_2}$ |
|---|---|---|
| 0.0951 | 0.0061 | 15.59 |
| 0.246 | 0.0169 | 14.56 |
| 0.747 | 0.0565 | 13.22 |
| 1.421 | 0.118 | 11.96 |
| 2.289 | 0.191 | 11.98 |
| 3.336 | 0.267 | 12.50 |
| 5.315 | 0.398 | 13.35 |
| 7.066 | 0.607 | 11.64 |
| 7.831 | 1.512 | 5.18 |
| 7.982 | 1.616 | 4.94 |

### Water and Methyl Iodide

| Gm. Equiv. $CH_2ClCOOH$ per liter of: $H_2O$ layer ($C_1$) | $CH_3I$ layer ($C_2$) | $\frac{C_1}{C_2}$ |
|---|---|---|
| 0.213 | 0.0046 | 46.3 |
| 0.352 | 0.0082 | 42.9 |
| 0.617 | 0.0162 | 38.1 |
| 1.468 | 0.0501 | 29.3 |
| 2.503 | 0.0929 | 26.9 |
| 3.485 | 0.131 | 26.6 |
| 4.811 | 0.174 | 27.65 |
| 6.028 | 0.243 | 24.8 |
| 7.464 | 0.366 | 20.4 |
| 8.623 | 0.700 | 12.3 |
| 8.688 | 1.103 | 7.88 |

### Water and Nitrobenzene

| Gm. Equiv. $CH_2ClCOOH$ per liter of: $H_2O$ layer ($C_1$) | $C_6H_5NO_3$ layer ($C_2$) | $\frac{C_1}{C_2}$ |
|---|---|---|
| 0.1260 | 0.0164 | 7.68 |
| 0.3314 | 0.0496 | 6.68 |
| 0.4070 | 0.0693 | 5.87 |
| 0.9160 | 0.1688 | 5.43 |
| 1.5750 | 0.3106 | 5.07 |
| 2.1420 | 0.4662 | 4.59 |
| 2.8728 | 0.6993 | 4.11 |
| 3.5595 | 0.8946 | 3.98 |
| 4.5665 | 1.2141 | 3.76 |
| 5.7441 | 1.7852 | 3.22 |

### Water and Toluene

| Gm. Equiv. $CHCl_2COOH$ per liter of: $H_2O$ layer ($C_2$) | $C_6H_5CH_3$ layer ($C_2$) | $\frac{C_1}{C_2}$ |
|---|---|---|
| 0.113 | 0.00126 | 89.6 |
| 0.176 | 0.0025 | 71.2 |
| 0.396 | 0.0088 | 45.0 |
| 0.746 | 0.019 | 39.5 |
| 1.191 | 0.032 | 37.2 |
| 2.394 | 0.066 | 36.0 |
| 4.397 | 0.124 | 35.5 |
| 6.733 | 0.228 | 29.5 |
| 8.417 | 0.385 | 21.8 |
| 9.337 | 0.730 | 12.8 |

## CHLORO ACETIC ACID

### Distribution of Chloro Acetic Acid at 25° Between:

(Kolossowsky, 1934; Kolossowsky and Kulikow, 1934, 1935.)

#### Water and o Nitro Toluene

| Gm. Equiv. $CH_2ClCOOH$ per liter of: $H_2O$ layer ($C_1$) | $C_6H_4CH_3NO_2$ layer ($C_2$) | $\frac{C_1}{C_2}$ |
|---|---|---|
| 0.0524 | 0.0055 | 9.53 |
| 0.1247 | 0.0142 | 8.78 |
| 0.2754 | 0.0319 | 8.63 |
| 0.832 | 0.1064 | 7.82 |
| 1.892 | 0.279 | 6.78 |
| 3.239 | 0.541 | 5.99 |
| 4.392 | 0.758 | 5.79 |
| 7.053 | 1.231 | 5.73* |
| 7.991 | 3.774 | 2.12* |
| 8.128 | 1.807 | 4.50* |
| 8.342 | 3.431 | 2.43* |
| 8.601 | 2.661 | 3.23* |

* The aqueous phase is the lower layer.

#### Water and Iso Butyl Alcohol

| Gm. Equiv. $CH_2ClCOOH$ per liter of: $H_2O$ layer ($C_1$) | 1 $C_4H_9OH$ layer ($C_2$) | $\frac{C_1}{C_2}$ |
|---|---|---|
| 0.0405 | 0.2596 | 0.156 |
| 0.0667 | 0.4221 | 0.158 |
| 0.1131 | 0.6779 | 0.167 |
| 0.2205 | 1.1718 | 0.188 |
| 0.2709 | 1.3356 | 0.203 |
| 0.3654 | 1.5530 | 0.235 |
| 0.3874 | 1.7104 | 0.227 |
| 0.5040 | 2.1136 | 0.239 |
| 0.6541 | 2.6813 | 0.244 |
| 0.8355 | 2.6738 | 0.312 |
| 0.8996 | 2.6705 | 0.337 |
| 1.4412 | 3.2570 | 0.442 |
| 2.1773 | 3.9782 | 0.547 |

#### Water and Normal Amyl Alcohol

| Gm. Equiv. $CH_2ClCOOH$ per liter of: $H_2O$ layer ($C_1$) | 11 $C_5H_{11}OH$ layer ($C_2$) | $\frac{C_1}{C_2}$ |
|---|---|---|
| 0.0718 | 0.2577 | 0.279 |
| 0.1612 | 0.6426 | 0.251 |
| 0.2530 | 1.2017 | 0.211 |
| 0.3937 | 2.0034 | 0.197 |
| 0.4945 | 2.3782 | 0.208 |
| 1.1538 | 3.5489 | 0.325 |
| 1.7516 | 3.9966 | 0.438 |
| 2.2042 | 4.1655 | 0.529 |
| 3.0182 | 4.8469 | 0.623 |
| 3.7117 | 5.7644 | 0.644 |

#### Water and Iso Amyl Alcohol

| Gm. Equiv. $CH_2ClCOOH$ per liter of: $H_2O$ layer ($C_1$) | 1 $C_6H_5OH$ layer ($C_2$) | $\frac{C_1}{C_2}$ |
|---|---|---|
| 0.0170 | 0.1242 | 0.137 |
| 0.0409 | 0.2425 | 0.169 |
| 0.0756 | 0.4447 | 0.170 |
| 0.1588 | 0.9148 | 0.174 |
| 0.3150 | 1.2915 | 0.244 |
| 0.4630 | 1.9719 | 0.234 |
| 0.7056 | 3.0966 | 0.228 |
| 1.0232 | 3.1360 | 0.326 |
| 1.2889 | 3.3537 | 0.384 |
| 2.7910 | 4.4419 | 0.628 |

### Distribution of Chloro Acetic Acid Between Water and Olive Oil.

(Bodansky and Meigs, 1932.)

#### Results at 25°

| Gm. Mol. $CH_2ClCOOH$ per liter of: $H_2O$ layer ($C_1$) | Olive Oil layer ($C_2$) | $\frac{C_1}{C_2}$ |
|---|---|---|
| 0.0092 | 0.0006 | 15.30 |
| 0.0928 | 0.0090 | 10.31 |
| 0.1850 | 0.0180 | 10.27 |

#### Results at 37.5°

| Gm. Mol. $CH_2ClCOOH$ per liter of: $H_2O$ layer ($C_1$) | Olive Oil layer ($C_2$) | $\frac{C_1}{C_2}$ |
|---|---|---|
| 0.0092 | 0.0005 | 18.40 |
| 0.0175 | 0.0010 | 17.50 |
| 0.0455 | 0.0030 | 15.15 |
| 0.0895 | 0.0090 | 9.95 |

DISTRIBUTION OF CHLORO ACETIC ACID AT 25° BETWEEN n DIBUTYL ETHER AND:
(Randall and Failey, 1927.)

| Aq. Magnesium Sulfate Solutions | | | | Aq. Potassium Sulfate Solutions | | | |
|---|---|---|---|---|---|---|---|
| d. of aq. $MgSO_4$ solution | Ionic Conc. of added $MgSO_4$ | Molality of $CH_2ClCOOH$ in aq. layer | Mol. Fraction $CH_2ClCOOH$ in ether layer | d. of aq. $K_2SO_4$ solution | Ionic Conc. of added $K_2SO_4$ | Molality of $CH_2ClCOOH$ in aq. layer | Mol. Fraction $CH_2ClCOOH$ in ether layer |
| 1.003 | 0.242 | 0.1012 | 0.004554 | 1.008 | 0.300 | 0.1036 | 0.004356 |
| 1.010 | 0.492 | 0.1044 | 0.004661 | 1.039 | 1.000 | 0.1135 | 0.004358 |
| 1.023 | 0.970 | 0.1055 | 0.004783 | 1.058 | 1.500 | 0.1128 | 0.004298 |
| 1.049 | 1.880 | 0.1035 | 0.004992 | 1.078 | 2.000 | 0.1173 | 0.004372 |

The critical solution temperature of mixtures of chloro acetic acid and o Cresol is at about 37°. (Lecat, 1927a.)

Freezing-point data are given for mixtures of Chloro Acetic Acid and each of the following compounds:

Di chloro Acetic Acid (1)
Tri chloro Acetic Acid (1)
Acetophenone (2)
Benzene (4)
Benzil (3)
Benzoic Acid (1)
Camphor (5)
Cetyl Alcohol (6)
Cinnamic Acid (1)
o, m, p Cresol (1) (12)
Crotonic Acid (1)
Di benzyl Acetone (2)
Di methyl Oxalate (7)
Di methyl Succinate (7)
Di methyl pyrone (8)
Erythritol (13)
Guaicol (12)(14)
Methyl cinnamate (7)
Naphthalene (6)(9)(10)
α, β Naphthol (12)
Phenol (10)(11)(12)
Piperonal (2)(6)
Salol (6)
Sulfuric Acid (15)
Thymol (12)
o m p α Toluic Acids (1)
Urea (14)
Urethan (14)
Vanillin (3)

(1) Kendall, 1914; (2)(3) Kendall and Gibbons, 1915; (4)(7) Kendall and Booge, 1916; (5) Pawlewski, 1893; (6) Mameli and Mannessier, 1913; (8) Kendall, 1914a; (9) Miers and Isaac, 1908; (10) Mameli and Mannessier-Mameli, 1933; (11) Kendall, 1916; (12) Mameli and Cocconi, 1923; (13) (13) Puschin and Dezelic, 1932; (14) Puschin and Rikovsky, 1933; (15) Kendall and Carpenter, 1914.

## CHLORAL HYDRATE $CCl_3.CH(OH)_2$.

SOLUBILITY OF CHLORAL HYDRATE IN WATER, ETHYL ALCOHOL, CHLOROFORM AND IN TOLUENE. (Speyers, 1902.)

| | In Water | | In Alcohol | | In Chloroform | | In Toluene | |
|---|---|---|---|---|---|---|---|---|
| t° | W. | S. | W. | S. | W. | S. | W. | S. |
| 0... | 1.433 | 239 | 1.11 | 188 | 1.530 | 3.8 | 0.848 | 3.25 |
| 5... | 1.460 | 292 | 1.16 | 200 | 1.515 | 4.1 | 0.900 | 5.5 |
| 10... | 1.485 | 375 | 1.23 | 220 | 1.510 | 5.2 | 0.910 | 8.0 |
| 15... | 1.510 | 495 | 1.30 | 310 | 1.505 | 8.0 | 0.915 | 13.0 |
| 20... | 1.535 | 660 | 1.36 | 425 | 1.510 | 15.5 | 0.94 | 21.0 |
| 25... | 1.555 | 825 | 1.42 | 610 | 1.520 | 33.0 | 0.97 | 31.0 |
| 30... | 1.580 | 1005 | 1.49 | 950 | 1.540 | 65.0 (27°.7) | 1.02 | 50.0 |
| 35... | 1.590 | 1210 | 1.55 | 1590 | 1.570 | – | 1.13 | 77.0 |
| 40... | 1.605 | 1430 | 1.60 | 2780 | 1.590 | ∞ | 1.40 | 124.0 |
| 45... | 1.620 | – | – | 5600 | – | – | – | 200.0 |

W = Wt. in gms. of 1 cc. sat. sol.; S = Gms. $CCl_3.CH(OH)_2$ per 100 gms. solvent.

**CHLORAL HYDRATE** $CCl_3.CH(OH)_2$.

100 gms. abs. alcohol dissolve 215.0 gms. $CCl_3.CH(OH)_2$ at 20-25°. } (Pucher and Dehn, 1921.)
» quinoline » 12.56 » » » » »
100 gms. equi molecular mixture of alcohol and quinoline dissolve 0.58 gms. $CCl_3.CH(OH)_2$ at 20-25°

### Solubility of Chloral Hydrate in Several Solvents.

| Solvent. | t°. | Gms. $CCl_3COH.H_2O$ per 100 Gms. Solvent. | Solvent | t°. | Gms. $CCl_3COH.H_2O$ 100 Gms. Solvent. |
|---|---|---|---|---|---|
| 50% Aq. Pyridine | 20–25 | 374 (Dehn, 1917.) | Ether | ord. t. | 200 (Squires.) |
| Pyridine | 20–25 | 80.9 " | Oil turpentine | cold | 10 " |
| Carbon Disulfide | ord. t. | 1.47 (Squires.) | | hot | 20 " |
| Glycerol | ord. t. | 200 " | Olive Oil | ord. t. | 100 " |

### Distribution of Chloral Hydrate Between Water and Organic Solvents.

| Immiscible Solvents. | t. | Dist. Coef. $\frac{\text{Conc. in } H_2O}{\text{Conc. in Org. Solvent.}}$ | Authority. |
|---|---|---|---|
| Water and Ether | 0–30° | 0.235 | (Hantzsch and Vagt, 1901.) |
| Water and Benzene | ... | ... | (Bubanovic, 1913.) |
| Water and Olive Oil | ord. | 4.9 | (Baum, 1899.) |
| " " " | 30° | 4.3 | (Meyer, 1901; 1909.) |
| " " " | 3 | 16.7 | (Meyer, 1901.) |
| " " Toluene | 0–20° | 58–74.5 | (Hantzsch and Vagt, 1901.) |

Experiments designed to show the distribution of chloral hydrate between water and gelatine and between water and egg albumin are described by Cooper and Treadgold, 1934.

### The Solidification Points of Mixtures of Antipyrine and Chloral Hydrate.

(Tsakalatos, 1913.)

| t° of Solidification. | Gms. $C_{11}H_{12}N_2O$ per 100 Gms. Mixture. | Solid Phase. | t° of Solidification. | Gms. $C_{11}H_{12}N_2O$ per 100 Gms. Mixture. | Solid Phase. |
|---|---|---|---|---|---|
| 108.9 | 100 | $C_{11}H_{12}N_2O$ | 60 | 40.9 | 1.2 |
| 90 | 86.1 | " | 61.8 m. pt. | 36.7 | " |
| 70 | 73 | " | 57 | 30.1 | " |
| 50.5 Eutec. | 64.2 | "+1.1 | 50 | 26.1 | " |
| 60 | 56.8 | 1.1 | 40 | 20.2 | " |
| 62.3 m. pt. | 53.2 | " | 33.8 Eutec. | 16.5 | $1.2+CCl_3.COH.H_2O$ |
| 60 | 50.3 | " | 40 | 6 | $CCl_3.COH.H_2O$ |
| 56 Eutec. | 47.2 | "+1.2 | 51.6 | 0 | " |

1.1 = $C_{11}H_{12}N_2O.CCl_3COH.H_2O$ (Hypnal).
1.2 = $C_{11}H_{12}N_2O.2(CCl_3.COH.H_2O)$ (Bihypnal).

Freezing-point data are given for:

Chloral hydrate + Acetanilide (Angeletti, 1928.)
" " + Salol (Bellucci, 1912, 1913.)
" " + Camphor (Tsakalotos, 1915.)
" " + Menthol (Pawlewski, 1893.)
" " + Sarcosine anhydride (Pfeiffer and Seydel, 1928.)

## IODO ACETIC ACID $CH_2ICOOH$.

### Distribution of Iodo Acetic Acid at 25° Between:
(Smith and White, 1929.)

| Water and Chloroform | | Water and Benzene | |
|---|---|---|---|
| Gm. Mols. $CH_2ICCOH$ per liter of: | | Gm. Mols. $CH_2ICOOH$ per liter of: | |
| $H_2O$ layer | $CHCl_3$ layer | $H_2O$ layer | $C_6H_6$ layer |
| 0.01388 | 0.00187 | 0.01543 | 0.00111 |
| 0.01655 | 0.00230 | 0.01996 | 0.00151 |
| 0.02080 | 0.00301 | 0.02531 | 0.00197 |
| 0.02350 | 0.00345 | 0.02748 | 0.00222 |
| 0.02788 | 0.00430 | 0.02950 | 0.00240 |

| Water and Chloroform | | Water and Benzene | |
|---|---|---|---|
| Gm. Mols. $CH_2ICOOH$ per liter of: | | Gm. Mols. $CH_2ICOOH$ per liter of: | |
| $H_2O$ layer | $CHCl_3$ layer | $H_2O$ layer | $C_6H_6$ layer |
| 0.03213 | 0.00496 | 0.03221 | 0.00266 |
| 0.03831 | 0.00621 | 0.03530 | 0.00300 |
| 0.04190 | 0.00708 | 0.03840 | 0.00334 |
| 0.05085 | 0.00895 | 0.04840 | 0.00457 |
| 0.06465 | 0.01220 | 0.07070 | 0.00758 |

### Distribution of Iodo Acetic Acid Between Water and Olive Oil.
(Bodansky and Meigs, 1932.)

| t° | Gm. Mols. $CH_2ICOOH$ per liter of: | | $\frac{C_1}{C_2}$ |
|---|---|---|---|
| | $H_2O$ layer ($C_1$) | Olive Oil layer ($C_2$) | |
| 25 | 0.0145 | 0.0050 | 2.90 |
| 37.5 | 0.0355 | 0.0140 | 2.54 |
| " | 0.0745 | 0.0250 | 2.98 |

## ETHYLENE $C_2H_4$. Solubility in Water and in Alcohol.
(Bunsen and Carius; Winkler, 1906.)

| t°. | $\beta$. | $q$. |
|---|---|---|
| 0 | 0.226 | 0.0281 |
| 5 | 0.191 | 0.0237 |
| 10 | 0.162 | 0.0200 |
| 15 | 0.139 | 0.0171 |
| 20 | 0.122 | 0.0150 |
| 25 | 0.108 | 0.0131 |
| 30 | 0.098 | 0.0118 |

Solubility in Alcohol.

| t°. | Vols. $C_2H_4$ per 100 Vols. Alcohol. |
|---|---|
| 0 | 359.5 |
| 4 | 337.5 |
| 10 | 308.6 |
| 15 | 288.2 |
| 20 | 271.3 |

For $\beta$ and $q$ see Ethane, p. 126

The solubility of Ethylene in Water at 25° in terms of the Bunsen Absorption Coefficient, $\beta$, was found by Orcutt and Seevers, 1936, to be 0.108. The authors made use of a modification of the Van Slyke-Neill, 1924, manometric apparatus which is based upon the principle of extracting the gas from the saturated solution and measuring its pressure. By means of a special technique and method of calculating the correction for unextracted gas, this becomes a simple method of determining the solubility of any gas in any liquid without the aid of previously determined constants.

100 cc $H_2O$ dissolve 11.6 cc $C_2H_4$ (reduced to 0° and 760 mm.) at 21°.
(Venable and Fuwa, 1922.)

## Solubility of Ethylene in Water, Plasma, Blood and Haemoglobin Solution at 25°.

(Grollman, 1929.)

| Partial pressure of $C_2H_4$ | Solubility in terms of the Ostwald Expression $l$ in: Water | Dog Plasma | Dog Blood | Aq. 8.5% Dog Haemoglobin Solution |
|---|---|---|---|---|
| 550 | 0.112 | 0.114 | 0.141 | 0.104 |
| 650 | 0.113 | 0.114 | 0.141 | 0.105 |
| 700 | 0.112 | 0.115 | 0.142 | 0.106 |
| 800 | 0.113 | 0.115 | 0.141 | 0.106 |
| 900 | 0.114 | 0.115 | 0.142 | 0.106 |
| 1000 | 0.113 | 0.117 | 0.144 | 0.107 |

## Solubility of Ethylene in Water and in Blood at 37.5°.

(Grollman, 1929.)

| Solvent | Solubility in terms of the Bunsen Abs. Coef. $\beta$: cc $C_2H_4$ per 1.0 cc solution | cc $C_2H_4$ per 1.0 gm. $H_2O$ |
|---|---|---|
| Water | 0.078 | 0.0785 |
| Whole Human Blood | 0.123 | 0.156 |
| " Dog " | 0.141 | 0.167 |
| " Rabbit " | 0.128 | 0.148 |
| Aq. Lipoidal suspension (1) | 0.120 | |

(1) Containing per 100 cc of $H_2O$, 0.3 gm. Blood Lipoid prepared by extracting blood corpuscles with ethyl ether and petroleum ether.

## Solubility of Ethylene in Aqueous Solutions of Alkali Hydroxides, Etc., at 15°. (Billitzer, 1902.)

Results in terms of the Ostwald Solubility Expression $l$. See p. 37.

| Aqueous Solution of: | Solubility $l_{15}$ in Aq. Solution of Normality: 0.1. | 0.25. | 0.5. | 0.75. | 1.0. |
|---|---|---|---|---|---|
| KOH | 0.154 | 0.144 | 0.130 | 0.118 | 0.1056 |
| NaOH | 0.153 | 0.144 | 0.128 | 0.114 | 0.101 |
| $NH_4OH$ | ... | 0.157 | 0.156 | 0.155 | 0.154 |
| $\frac{1}{2}$ $Na_2SO_4$ | 0.1525 | 0.1425 | 0.127 | 0.109 | 0.093 |
| In $H_2O$ alone | 0.1593 | ... | ... | ... | ... |

## Solubility of Ethylene in Methyl Alcohol and in Acetone. (Levi, 1901.)

Results in terms of the Ostwald Solubility Expression $l$. See p. 37.

| t°. | In Methyl Alcohol. | In Acetone. | t°. | In Methyl Alcohol. | In Acetone. |
|---|---|---|---|---|---|
| 0 | 3.3924 | 4.0652 | 30 | 1.8585 | 1.8680 |
| 10 | 2.8831 | 3.3580 | 40 | 1.3432 | 1.0852 |
| 20 | 2.3718 | 2.6278 | 50 | 0.8259 | 0.2772 |
| 25 | 2.1154 | 2.2500 | 60 | 0.3506 | ... |

The formulas from which the above figures were calculated are:

In Methyl Alcohol, $l = 3.3924 - 0.05083\,t - 0.00001\,t^2$.

In Acetone, $l = 4.0652 - 0.06946\,t - 0.000126\,t^2$.

SOLUBILITY OF ETHYLENE IN SEVERAL SOLVENTS. (McDaniel, 1911.)

| Solvent. | t°. | Abs. Coef. *A*. | Bunsen Coef. $\beta$. | Solvent. | t°. | Abs. Coef. *A*. | Bunsen Coef. $\beta$. |
|---|---|---|---|---|---|---|---|
| Benzene | 22 | 3.010 | 2.786 | Heptane | 22.4 | 3.463 | 3.207 |
| " | 35 | 2.655 | 2.353 | " | 35 | 3.186 | 2.824 |
| " | 50 | 2.482 | 2.100 | " | 39 | 3.110 | 2.722 |
| Hexane | 22 | 3.038 | 2.8141 | Acetone | 20 | 2.571 | 2.290 |
| " | 35 | 2.826 | 2.505 | " | 35 | 2.308 | 2.046 |
| " | 45 | 2.586 | 2.219 | Limonene | 22 | no constant equilibrium | |

Abs. Coef. *A* = vol. of ethylene absorbed by unit vol. of solvent at temp. stated.
For definition of Bunsen Coef. $\beta$, see 1137.
The Coef. of Abs. $\beta$ of ethylene in Russian petroleum is 0.164 at 10° and 0.142 at 20°.
(Gniewosz and Walfisz, 1887.)

1.0 cc. of absolute ethyl alcohol dissolves at t° (pressure not stated) $3.59498 - 0.057716\ t + 0.0006812\ t^2$ cc. of ethylene. (Spörry, 1922. 1926.)
100 cc. of rubber dissolve 144.0 cc. (reduced to 0° of 760 mm.) ethylene at 21°.
(Venable and Fuwa, 1922.)

The solubility of Ethylene in cyclohexanol is 0.299 at 26° in terms of the Ostwald Solubility Expression. (Cauquil, 1927.)

SOLUBILITY OF ETHYLENE IN SEVERAL SOLVENTS AT VARIOUS TEMPERATURES.
(Horiuti, 1931.)

| t° | Solubility of $C_2H_4$ in terms of the Ostwald Solubility Expression *l* in: | | | | |
|---|---|---|---|---|---|
| | $CCl_4$ | $(CH_3)_2CO$ | $CH_3COOCH_3$ | $C_6H_6$ | $C_6H_5Cl$ |
| 0 | 5.027 | 4.843 | 4.618 | — | 3.882 |
| 5 | 4.689 | 4.572 | 4.379 | 4.268 | 3.640 |
| 10 | 4.415 | 4.308 | 4.156 | 4.017 | 3.425 |
| 15 | 4.159 | 4.074 | 3.914 | 3.796 | 3.221 |
| 20 | 3.922 | 3.847 | 3.709 | 3.591 | 3.018 |
| 25 | 3.711 | 3.640 | 3.521 | 3.403 | 2.887 |
| 30 | 3.511 | 3.473 | 3.348 | 3.241 | 2.714 |
| 35 | 3.341 | 3.285 | 3.185 | 3.087 | 2.576 |
| 40 | 3.163 | 3.142 | 3.049 | 2.955 | 2.460 |
| 50 | — | — | — | 2.708 | 2.265 |
| 60 | — | — | — | — | 2.084 |
| 70 | — | — | — | — | 1.932 |
| 80 | — | — | — | — | 1.815 |
| 90 | — | — | — | — | 1.707 |

## Solubility of Ethylene in Several Solvents at Various Temperatures and Pressures.

(Kirejew, Kaplan and Romantchouk, 1935.)

| Solvent | t° | cc $C_2H_4$ (reduced to 0° and 760 mm) dissolved by 1 cc. solvent at: 50 | 100 | 200 | 300 | 400 | 500 | 600 | 700 | 760 mm Hg pressure |
|---|---|---|---|---|---|---|---|---|---|---|
| Kerosene | -21 | — | 1.0 | 2.0 | 3.05 | 4.10 | 5.10 | 6.10 | 7.10 | 7.65 |
| " | -10 | — | 0.80 | 1.60 | 2.40 | 3.25 | 4.10 | 4.90 | 5.65 | 6.15 |
| " | 0 | — | 0.70 | 1.40 | 2.05 | 2.65 | 3.25 | 3.85 | 4.50 | 4.90 |
| " | +20 | — | 0.55 | 1.10 | 1.55 | 1.95 | 2.30 | 2.70 | 3.10 | 3.32 |
| " | 40 | — | 0.35 | 0.65 | 0.95 | 1.30 | 1.65 | 1.95 | 2.20 | 2.35 |
| Xylol | -21 | 0.85 | 1.35 | 2.60 | 3.82 | 5.00 | 6.15 | 7.35 | 8.45 | 9.40 |
| " | -10 | 0.70 | 1.20 | 2.40 | 3.25 | 4.10 | 5.00 | 5.95 | 6.90 | 7.50 |
| " | 0 | 0.55 | 0.90 | 1.80 | 2.30 | 3.40 | 4.10 | 4.80 | 5.50 | 5.95 |
| " | +20 | 0.30 | 0.45 | 0.90 | 1.45 | 1.95 | 2.50 | 3.00 | 3.50 | 3.80 |
| " | 40 | 0.25 | 0.40 | 0.85 | 1.20 | 1.75 | 2.25 | 2.60 | 2.80 | 3.03 |
| Cracked gasoline | -21 | — | 1.35 | 2.75 | 3.95 | 5.15 | 6.30 | 7.45 | 8.45 | 9.05 |
| " " | -10 | — | 1.10 | 2.20 | 3.30 | 4.30 | 5.25 | 6.25 | 6.95 | 7.40 |
| " " | 0 | — | 0.95 | 1.95 | 2.95 | 3.80 | 4.55 | 5.30 | 5.95 | 6.40 |
| " " | +20 | — | 0.75 | 1.50 | 2.30 | 3.05 | 3.70 | 4.20 | 4.50 | 4.60 |
| " " | 40 | — | 0.65 | 1.30 | 1.80 | 2.30 | 2.70 | 3.05 | 3.40 | 3.60 |
| Di chloro Ethane | 0 | 0.25 | 0.55 | 11.15 | 1.80 | 2.40 | 3.00 | 3.55 | 4.15 | 4.50 |
| Light Solvent | 0 | 0.30 | 0.60 | 1.25 | 1.90 | 2.60 | 3.25 | 3.85 | 4.45 | 4.80 |

Freezing-point data are given for mixtures of ethylene and di methyl ether by Baume and Germann, 1911, 1914.)

**BROMO ETHANE** 1,2 (Ethylene Bromide) $CH_2BrCH_2Br$.

### Solubility of Ethylene Bromide in Water.

(Gross and Saylor, 1931; Van Arkel and Vles, 1936.)

| t° | Gms. $C_2H_4Br_2$ per 100 gms. $H_2O$ | t° | Gms. $C_2H_4Br_2$ per 100 gms. $H_2O$ |
|---|---|---|---|
| 0 | 0.335 | 30 | 0.431 |
| 15 | 0.392 | 35 | 0.451 |
| 20 | 0.404 | 50 | 0.532 |

Freezing-point data are given for mixtures of 1.2 Di bromo Ethane (Ethylene Bromide) and each of the following compounds.

Acetic Acid (1)(2)
Aniline (8)(9)
Azoxyanisol (11)
Benzene (1)(5)(6)
Bromo Toluene (4)
Carbon Tetra Chloride (5)
Chloro Benzene (5)
1.2-Dichloro Ethane (7)
Di ethyl di acetyl tartrate(14)
cis Dichloro Ethylene (7)
trans " " (7)
Di phenyl amine (1)
Ethyl Bromide (8)(10)
Menthol (1)
Naphthalene (1) (2)
β Naphthol (3)
" + Picric Acid (3)
Ethylene Chloride (10)
o,m and p Nitroaniline (11)
Nitro Benzene (1)(5)
Paraldehyde (4)
Propylene Bromide (12)
1,1,2,2 Tetra Bromo Ethane (10)
" " Chloro " (10)
Toluene (2)
p Xylene (4)
Cyclohexane(13)

(1) Dahnes, 1895; (2) Baud, 1912; (3) Bruni, 1898; (4) Paterno and Ampola, 1897; (5) Linard, 1925; (6) Baud and Gay, 1911; (7) Timmermans, 1927; (8) Timmermans, 1928; (9) Timmermans, 1930; (10) Timmermans and Mme. Vesselovsky, 1931; (11) Bogojewlensky, Winogradow and Bogolubow, 1906; (12) Timmermans, 1934. (13) Baud, 1913b; (14) Batelli, 1883.

**BROMO CHLORO ETHANE** $CH_2ClCH_2Br$.

1000 gms. $H_2O$ dissolve 6.88 gms. $C_2H_4BrCl$ at 30°. (Gross, Saylor and Gorman, 1933.)

**DICHLORO ETHANE** 1.2 (Ethylene Chloride) $CH_2ClCH_2Cl$.

SOLUBILITY OF ETHYLENE CHLORIDE IN WATER.
(Rex, 1906; Gross, 1929, 1929 (a); Gross and Saylor, 1931.)

| t° | Gms. $C_2H_4Cl_2$ per 100 gms. $H_2O$ | t° | Gms. $C_2H_4Cl_2$ per 100 gms. $H_2O$ |
|---|---|---|---|
| 0 | 0.922 (0.873) | 20 | 0.869 (0.849) |
| 10 | 0.885 | 25 | 0.865 (0.895, 35°) |
| 15 | 0.872 | 30 | 0.894 (1.030, 56°) |

The results in parentheses are by Van Arkel and Vles, 1936.

100 gms. aq. 0.5 n KCl dissolve 0.752 gm. $C_2H_4Cl_2$ at 25°.
" " " 0.5 n $MgSO_4$ " 0.552 gm. " " "

Determinations of the vapor pressures of concentrations of ethylene chloride less than saturation in water at 30° are given by Saylor, Stuckey and Gross, 1938.

MISCIBILITY OF ETHYL ALCOHOL (see Note, p. 4 ) AT 0° WITH MIXTURES OF:

Ethylene Chloride and Water.
(Bonner, 1910.)

Composition of Homogeneous Mixtures.

| Gms. $CH_2Cl.CH_2Cl$. | Gms. $H_2O$. | Gms. $C_2H_5OH$. | Sp. Gr. Sat. Sol. |
|---|---|---|---|
| 0.971 | 0.029 | 0.191 | 1.15 |
| 0.90 | 0.10 | 0.42 | 1.08 |
| *0.88 | 0.12 | 0.46 | ... |
| 0.792 | 0.208 | 0.670 | 1.01 |
| 0.70 | 0.30 | 0.80 | 0.98 |
| 0.60 | 0.40 | 0.93 | 0.96 |
| 0.50 | 0.50 | 0.99 | 0.95 |
| 0.40 | 0.60 | 1.01 | 0.94 |
| 0.30 | 0.70 | 0.99 | 0.94 |
| 0.20 | 0.80 | 0.95 | 0.94 |
| 0.095 | 0.905 | 0.842 | 0.96 |
| 0.02 | 0.980 | 0.514 | 0.97 |

Ethylidene Chloride and Water.
(Bonner, 1910.)

Composition of Homogeneous Mixtures.

| Gms. $CH_3.CHCl_2$. | Gms. $H_2O$. | Gms. $C_2H_5OH$. | Sp. Gr. Sat. Sol. |
|---|---|---|---|
| 0.985 | 0.015 | 0.226 | 1.10 |
| 0.90 | 0.10 | 0.43 | 1.03 |
| 0.805 | 0.195 | 0.586 | 1.01 |
| 0.70 | 0.30 | 0.69 | 0.98 |
| *0.67 | 0.33 | 0.72 | ... |
| 0.60 | 0.40 | 0.77 | 0.96 |
| 0.50 | 0.50 | 0.82 | 0.95 |
| 0.437 | 0.563 | 0.857 | 0.94 |
| 0.30 | 0.70 | 0.88 | 0.93 |
| 0.20 | 0.80 | 0.86 | 0.93 |
| 0.10 | 0.90 | 0.79 | 0.94 |
| 0.03 | 0.97 | 0.576 | 0.95 |

Freezing-point data are given for mixtures of 1.2 Dichloro Ethane and each of the following compounds.

| | | |
|---|---|---|
| Carbon Disulfide (3) | 1.2 Dicyan Ethane (2) | Succinic Acid (2) |
| Benzene (4) (5) | 1.2 Dibrom Ethane (1)(2) | 1.1.2.2-Tetra bromo Ethane (2) |
| Benzene Tetra Chloride (6) | Ethylene Bromide (1) | 1.1.2.2 Tetra chloro Ethane (2) |
| cis Dichloro Ethylene (1) | Ethyl Ether (4) | 1.1.2 Tri chloro Ethane (2) |
| trans " " (1) | Penta chloro Ethane (2) | |

(1) Timmermans, 1927; (2) Timmermans and Mme. Vesselovsky, 1931; (3) Hammick and Howard, 1932; (4) Huettig and Smyth, 1935; (5) Baud and Gay, 1910, 1911; (6) Timmermans, 1934.

**DICHLORO ETHANE** 1.1 (Ethylidene Chloride) $CHCl_2CH_3$.

SOLUBILITY OF ETHYLIDENE CHLORIDE IN WATER.
(Rex, 1906; Gross and Saylor, 1931.)

| $t^0$ | Gms. $C_2H_4Cl_2$ per 100 gms. $H_2O$ |
|---|---|
| 0 | 0.656 (0.594) |
| 10 | 0.595 |
| 20 | 0.550 (0.506) |
| 25 | 0.506 |
| 30 | 0.540 (0.482, 35°) |
| 50 | — (0.519) |

The results in parentheses are by Van Arkel and Vles, 1936.)

100 gms. Aq. 0.5 n KCl dissolve 0.443 gms. $C_2H_4Cl_2$ at 25°.
" " " 0.5 n $MgSO_4$ " 0.316 " " " " "

Freezing-point data are given by Timmermans, 1934 for mixtures of Ethylidene Chloride and Methylene Chloride, iso butyl bromide and toluene.

**DI IODO ETHANE** 1.2-$CH_2I.CH_2I$.

Freezing-point data for mixtures of di iodo ethane and dioxan are given by Rheinboldt and Luyken, 1932.

**DiCYANODIAMIDE** $(H_2CN_2)_2$ (Polymerized cyanamide).

SOLUBILITY IN WATER, IN ALCOHOL AND IN ETHER.
(Hetherington and Braham, 1923.)

In Water.

| t° | Gms. $(H_2CN_2)_2$ per 100 gms. $H_2O$. |
|---|---|
| 0..... | 1.27 |
| 13..... | 2.26 |
| 15..... | 2.56 |
| 25..... | 4.13 |
| 39.9..... | 7.76 |
| 49.8..... | 11.80 |
| 60.1..... | 18.75 |
| 74.5..... | 32.58-33.41 |

In Ethyl Alcohol $\left(d_{\frac{20}{4}} = 0.790\right)$.

| t°. | Gms. $(H_2CN_2)$ per 100 gms. Alcohol. |
|---|---|
| 0..... | 0.937 |
| 13.0..... | 1.26 |
| 26.4..... | 1.70 |
| 35.0..... | 2.26 |
| 49.9..... | 3.30 |
| 60.1..... | 4.13 |

In Ethyl Ether (dried over Na).

| t°. | Gms. $(H_2CN_2)_2$ per 100 gms. Ether. |
|---|---|
| 0..... | 0.0006 |
| 13.0 .... | 0.01* |
| 25.0..... | 0.0015 |
| 35.3..... | 0.0026 |

* Pohl, *J. prakt. Chem.* [2]. 77, 534, 1908.

Freezing-point data are given for:

Dicyan di amide + Urea (Jänecke and Rahlfs, 1930.)
" + Cyanamide (Pratolonga, 1914.)

**GLYOXIME** $CH(:NOH).CH(:NOH)$.

Freezing-point data are given by Semeria and Bocca, 1926, for the following systems: glyoxime + xanthone, methyl glyoxime + xanthone, dimethyl glyoxime + xanthone and methyl ethyl glyoxime + xanthone.

**GLYCOL DINITRATE** $CH_2ONO_2.CH_2ONO_2$.

One liter of water dissolves 6.2 gms. $CH_2ONO_2.CH_2ONO_2$ at 15°, 6.8 gms. at 20° and 9.2 gms. at 50°. (Rinkenbach, 1926, quoted from Naoum, 1924

**ACETALDEHYDE** $CH_3COH$.

Solubility in Ethyl Alcohol Determined by the Method of Lowering of Freezing-point (de Leeuw, 1911). Liquid air was used as the cooling medium and temperatures were measured with the aid of a specially constructed resistance thermometer.

| t°. | Wt. Per Cent $CH_3COH$ in Mixture. | Mol. Per Cent $CH_3COH$ in Mixture. | Solid Phase. | t°. | Wt. Per Cent $CH_3COH$ in Mixture. | Mol. Per Cent $CH_3COH$ in Mixture. | Solid Phase. |
|---|---|---|---|---|---|---|---|
| −123.3 | 100 | 100 | $CH_3COH$ | −122.3 | 51.8 | 50.7 | $CH_3COH.C_2H_5OH$ |
| −125.4 | 90.7 | 90.3 | " | −125.3 | 45.6 | 44.5 | " |
| −127.6 | 84.5 | 83.9 | " | −128 | 40.6 | 39.5 | $CH_3COH.2C_2H_5OH$ |
| −132 | 80.9 | 80.2 | (Eutectic) | −123.2 | 35.3 | 34.3 | " |
| −126 | 78.1 | 77.3 | $CH_3COH.C_2H_5OH$ | −126.8 | 30.2 | 29.3 | " |
| −126 | 75.2 | 74.4 | " | −130.6 | 17.9 | 17.3 | $C_2H_5OH$ |
| −124.3 | 67.0 | 66.0 | " | −120.6 | 10.2 | 9.8 | " |
| −123.5 | 60.8 | 59.7 | " | −114.9 | 0.0 | 0.0 | " |

Freezing-point data for mixtures of acetaldehyde and paraldehyde as well as the complete $x - T$ diagrams are given by Holleman (1903). Results for mixtures of paraldehyde and $p$ xylene are given by Paterno and Ampola (1897).

Results for mixtures of the $\alpha$ and $\beta$ forms of Acetaldehyde phenyl hydrazone are given by Laws and Sidgwick (1911).

**ETHYLENE OXIDE** $(CH_2)_2O$.

Solubility of Ethylene Oxide in Water and in Dichloro Ethane.
(Kaplan and Reformatskaja, 1937.)

| Solvent | t° | cc $(CH_2)_2O$ (reduced to 0° and 760 mm.) dissolved per 1.0 cc solvent at a pressure of: | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | 150 | 200 | 300 | 400 | 500 | 600 | 700 | 760mm Hg |
| Water | 5 | 45 | 60 | 105 | 162 | 240 | — | — | — |
| " | 10 | 33 | 46 | 76 | 120 | 178 | 294 | — | — |
| " | 20 | 20 | 29 | 49 | 74 | 101 | 134 | 170 | 195 |
| Dichloro ethane | 0 | 99 | 130 | 380 | —. | — | — | — | — |
| " " | 10 | 50 | 80 | 199 | 365 | — | — | — | — |
| " " | 20 | 22 | 42 | 101 | 180 | 274 | 412 | 506 (650) | — |

The authors also give results for the vapor pressures of ethylene oxide in water and di chloro ethane.

## ETHYLENE OXIDE $C_2H_4O$.

FREEZING-POINTS OF MIXTURES OF ETHYLENE OXIDE AND WATER.
(Maass and Boomer, 1922.)

| t°. | Per cent $C_2H_4O$. | t°. | Per cent $C_2H_4O$. | t°. | Per cent $C_2H_4O$. |
|---|---|---|---|---|---|
| — 0.2... | 6.0 | 10.5... | 34.0 | 7.2... | 63.5 |
| + 6.7... | 11.4 | 10.0... | 40.8 | 6.9... | 65.5 |
| 9.4... | 16.4 | 9.5... | 46.0 | 6.0... | 70.5 |
| 10.4... | 21.3 | 9.0... | 51.0 | 4.3... | 78.5 |
| 10.7... | 24.9 | 8.4... | 55.0 | — 0.9... | 92.0 |
| 10.7... | 28.0 | 7.5... | 62.0 | —111.3... | 100.0 |

## METHYL FORMATE $HCOO(CH_3)$.

FREEZING-POINTS OF MIXTURES OF METHYL FORMATE AND TIN TETRACHLORIDE
(Kournakov and Perelemouter, 1916.)

| Finält t°of melting..... | —5. | +26. | 50 6. | 80. | 83.3. | 81.7. | 71.2. | 68. | 51.4. | 38.4. | —33. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Mol. % $SnCl_4$..... | 10 | 15 | 20 | 27.5 | 33.3 | 40 | 52.3 | 64 | 84 | 94 | 100 |

The mol. compound has the composition $SnCl_4.2\ HCOO(CH_3)$ and m. pt.83°.3.

Freezing-point data for mixtures of methyl formate and ethyl acetate are given by Sapgir, 1929.

## ACETIC ACID $CH_3COOH$.

RECIPROCAL SOLUBILITY OF ACETIC ACID AND WATER DETERMINED BY THE METHOD OF LOWERING OF THE FREEZING-POINT.

| t°. | Gms. $CH_3COOH$ per 100 Gms. Sat. Solution. | Solid Phase. | t°. | Gms. $CH_3COOH$ per 100 Gms. Sat. Solution. | Solid Phase. |
|---|---|---|---|---|---|
| 0 | 0 | Ice | — 20 | 67.0 | $CH_3COOH$ |
| — 5 | 15.2 | " | — 15 | 72.3 | " |
| — 10 | 28.5 | " | — 10 | 77.5 | " |
| — 15 | 40.0 | " | — 5 | 82.2 | " |
| — 20 | 49.2 | " | 0 | 87.0 | " |
| — 25 | 57.0 | " | + 5 | 91.8 | " |
| — 26.7 | 60.0 | (Eutectic) | 10 | 95.8 | " |
| — 25 | 62.5 | $CH_3COOH$ | 16.6 | 100.0 | " |

The data in the above table were obtained by plotting the results of Pickering (1893), Roloff (1895), Dahms (1896) (1899), de Coppet (1899), Kremann (1907), Faucon (1910), Balló (1910), Groschuff (1911), Paterno and Salimei (1913), and Tsakalotos (1914), on cross-section paper and drawing a curve through the points in best agreement. In addition to making determinations of the freezing-points of the mixtures, Balló also analyzed the solid phases which separated, and showed that these contained, in all cases, increasing percentages of acid and, therefore, must have consisted of mixed crystals. This formation of mixed crystals is offered as an explanation of the abnormality of the freezing-point lowering of the system.

SOLUBILITY OF ACETIC ACID IN ETHYL ALCOHOL (98.9%) DETERMINED BY THE METHOD OF LOWERING OF FREEZING-POINT. (Pickering, 1893.)

| t°. | Gms. $CH_3COOH$ per 100 Gms. Sat. Solution. | Solid Phase. | t°. | Gms. $CH_3COOH$ per 100 Gms. Sat. Solution. | Solid Phase. |
|---|---|---|---|---|---|
| — 75 | 26.0 | $CH_3COOH$ | — 10 | 67.7 | $CH_3COOH$ |
| — 70 | 27.7 | " | — 5 | 73.2 | " |
| — 60 | 33.0 | " | 0 | 79.1 | " |
| — 50 | 38.2 | " | + 5 | 85.2 | " |
| — 40 | 43.7 | " | 10 | 91.5 | " |
| — 30 | 50.2 | " | 15 | 98.0 | " |
| — 20 | 58.0 | " | 16.6 | 100.0 | " |

(The original results were plotted on cross-section paper and the above figures read from the curve.)

### Reciprocal Solubility of Acetic Acid, Ethyl Ether and Water at 20°

(Sasaki, 1938.)

The determinations were made by titrating mixtures of two of the components with the third just to appearance of turbidity. The results show the binodal curve. Tie lines determined by a graphical method are shown on the author's diagram but the values are not marked in the table.

| cc per 100 cc sat. sol. | | | cc per 100 cc sat.ssol. | | | cc per 100 cc sat. sol. | | |
|---|---|---|---|---|---|---|---|---|
| $CH_3COOH$ | $(C_2H_5)_2O$ | $H_2O$ | $CH_3COOH$ | $(C_2H_5)_2O$ | $H_2O$ | $CH_3COOH$ | $(C_2H_5)_2O$ | $H_2O$ |
| 0 | 12.3 | 87.7 | 17.8 | 71.5 | 10.7 | 25.8 | 48.4 | 25.8 |
| 0 | 98.0 | 2.0 | 21.6 | 64.0 | 14.4 | 26.4 | 46.0 | 27.6 |
| 8.7 | 13.5 | 77.8 | 23.8 | 20.6 | 55.6 | 26.5 | 33.8 | 39.7 |
| 9.5 | 85.7 | 4.8 | 23.8 | 55.6 | 20.6 | 27.0 | 32.5 | 40.5 |
| 16.7 | 16.7 | 66.6 | 25.0 | 25.0 | 50.0 | 60.0 | 40.0 | ∞ |
| | | | | | | 70.0 | ∞ | 30.0 |

## ACETIC ACID $CH_3COOH$.

### Solubility in Aqueous Solutions of Epichlorhydrine.

(Leone and Benelli, 1922 )

The authors give data for the system $H_2O + CH_3CO\,OH + CH_2.O.CH\,CH_2\,Cl$. As a part of this study they determined tne temperature of elearing and of clouding when weighed amounts of aeetie aeid were added to aqueous solutions of epichlorhydrine of definite weight per cent concentrations. These results when plotted on cross-seetion paper yield straight lines from whieh the following figures were read. At temperatures above 80° the epichlorhydrine begins to reaet with the water.

| | Gms. $CH_3CO\,OH$ per 100 gms. saturated sofution in aq teous : | | | | |
|---|---|---|---|---|---|
| t°. | 9.97 % $C_3H_5OCl$. | 20.04 % $C_3H_5OCl$. | 39.77 % $C_3H_5OCl$. | 59.66 % $C_3H_5OCl$ | 89.04 % $C_3H_5OCl$. |
| 10..... | 13.1 | 25.5 | 29.9 | 29.2 | 17.9 |
| 20..... | 11.2 | 23.6 | 28.2 | 27.5 | 16.5 |
| 30..... | 9.2 | 21.7 | 26.5 | 25.9 | 15.0 |
| 40..... | 7.3 | 19.8 | 24.8 | 24.2 | 13.6 |
| 50..... | 5.4 | 17.9 | 23.2 | 22.5 | 12.2 |
| 60..... | 3.5 | 16.0 | 21.5 | 20.9 | 10.7 |
| 70..... | 1.6 | 14.1 | 19.8 | 19.2 | 9.3 |
| 80..... | 0.0 | 12.2 | 18.2 | 17.5 | 7 9 |

### Solubility of Epichlorhydrin in Aqueous Solutions of Acetic Acid.

(Leone and Benelli, 1922.)

Weighed amounts of aqueous acetic acid solutions of three concentrations were mixed with weighed amounts of epichlorhydrin and the temperatures of clearing and clouding determined. The results are all expressed in weight per cent. On account of reaction of the constituents, determinations could not be made above 80°. The authors' results were plotted and the following values for regular intervals of temperature were read from the curves. At each temperature there are two concentrations of epichlorhydrin at which saturation occurs. One represents the epichlorhydrin rich layer and the other the epichlorhydrin poor layer.

| | Aqueous 14.93 per cent $CH_3COOH$. | | Aqueous 30.49 per cent $CH_3COOH$. | | Aqueous 50.0 per cent $CH_3COOH$. | |
|---|---|---|---|---|---|---|
| | Wt. per cent $C_3H_5OCl$ in | | Wt. per cent $C_3H_5OCl$ in | | Wt. per cent $C_3H_5OCl$ in | |
| t° | lighter layer. | heavier layer. | lighter layer. | heavier layer. | lighter layer. | heavier layer. |
| 25..... | 9.0 | 98.5 | 16.5 | 97.2 | 50.0 | 94.2 |
| 30..... | 9.5 | 98.7 | 18.0 | 97.0 | 52.0 | 93.8 |
| 35..... | 10.0 | 98.0 | 19.0 | 96.5 | 54.5 | 93.2 |
| 40..... | 10.5 | 97.8 | 20.0 | 96.0 | 57.0 | 92.0 |
| 45..... | 11.0 | 97.5 | 22.0 | 95.3 | 60.0 | 91.0 |
| 50..... | 11.5 | 97.0 | 24.0 | 94.7 | 63.5 | 89.5 |
| 55..... | 12.0 | 96.5 | 26.0 | 94.0 | 67.5 | 87.5 |
| 60..... | 13.0 | 96.0 | 29.0 | 93.5 | 72.5 | 85.0 |
| 63 (crit. temp.). | – | – | – | – | 81.0 | |
| 65..... | 14.0 | 95.5 | 33.0 | 93.0 | | |
| 70..... | 15.0 | 95.0 | 37.5 | 92.5 | | |
| 75..... | 16.5 | 94.0 | 43.0 | 91.5 | | |
| 80..... | 18.5 | 93.0 | 50.0 | 90.0 | | |

### Isotherms for the System Epichlorhydrin, Acetic Acid and Water at 0°, 10°, 40° and 60°.

(Leone and Benelli, 1922.)

The authors' determinations were plotted on cross section paper and from the four curves the following values for regular intervals of concentration of acetic acid were read. At each concentration of acetic acid there are two concentrations of epichlorhydrin at which saturation occurs. There is a maximum for each curve which corresponds to the concentration of acetic acid above which the three constituents mix in all proportions. The results show for both acetic acid and epichlorhydrin the grams of each per 100 gms. of homogeneous mixture of the two with water.

| Gms. $CH_3COOH$ per 100 gms. sat. sol. | Gms. $C_3H_5OCl$ per 100 gms. sat. solution at | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 0°. | | 10°. | | 40°. | | 60°. | |
| 0..... | 6.48 | 98.91 | 6.52 | 98.72 | 7.00 | 98.0 | 8.0 | 97.0 |
| 5..... | 6.7 | 93.2 | 7.3 | 92.3 | 8.0 | 90.5 | 9.3 | 89.0 |
| 10..... | 7.5 | 86.2 | 8.3 | 85.2 | 9.2 | 82.0 | 11.4 | 80.0 |
| 15..... | 8.4 | 79.0 | 9.7 | 77.5 | 10.6 | 72.5 | 14.5 | 69.0 |
| 20..... | 9.7 | 70.0 | 11.5 | 68.5 | 13.8 | 60.7 | 22.5 | 53.5 |
| 22..... | 10.5 | 66.4 | 12.5 | 64.0 | 16.0 | 55.0 | 30.0 | 40.0 |
| 24..... | 11.0 | 62.0 | 13.5 | 59.0 | 20.0 | 48.0 | | |
| 26..... | 12.1 | 56.7 | 15.0 | 53.5 | 27.0 | 39.0 | | |
| 28..... | 13.8 | 51.0 | 17.5 | 45.5 | | | | |
| 30..... | 16.5 | 43.0 | 25.0 | 30.0 | | | | |
| 31..... | 18.7 | 37.0 | | | | | | |
| 32..... | 25.0 | 27.0 | | | | | | |

## ACETIC ACID

### Equilibrium in the System Acetic Acid, Aniline and Water.

(Angelescu and Motzoc, 1925.)

The determinations were made by titration with the aid of weight pipets, mixtures of two of the components with the third just to the appearance or disappearance of clouding. In order to locate the tie lines of the binodal curve determined by titration, the distribution of acetic acid between the aqueous and aniline layers was also determined.

Results at 0°

| Gms. per 100 gms. sat. solution | | |
|---|---|---|
| $C_6H_5NH_2$ | $CH_3COOH$ | $H_2O$ |
| 3.68 | — | 96.32 |
| 7.13 | 2.89 | 89.98 |
| 10.00 | 5.91 | 84.09 |
| 17.10 | 12.41 | 70.49 |
| 20.82 | 14.02 | 65.16 |
| 26.76 | 15.33 | 57.88 |
| 30.10 | 15.73 | 54.17 |
| 32.17 | 15.88 | 51.95 |
| 34.75 | 16.01 | 49.24 |
| 37.76 | 16.16 | 46.08 |
| 38.72 | 16.20 | 45.08 |
| 47.68 | 16.26 | 36.06 |
| 58.15 | 15.60 | 26.25 |
| 68.92 | 13.38 | 17.70 |
| 76.83 | 10.68 | 12.49 |
| 86.36 | 6.23 | 7.41 |
| 90.37 | 4.02 | 5.61 |
| 95.71 | — | 4.29 |

Results at 20°

| Gms. per 100 gms. sat. solution | | |
|---|---|---|
| $C_6H_5NH_2$ | $CH_3COOH$ | $H_2O$ |
| 3.59 | — | 96.41 |
| 4.14 | 0.35 | 95.51 |
| 5.30 | 1.41 | 93.29 |
| 7.58 | 3.87 | 88.55 |
| 9.31 | 6.08 | 84.61 |
| 11.05 | 8.08 | 80.87 |
| 13.29 | 10.25 | 76.46 |
| 15.73 | 12.16 | 72.11 |
| 18.68 | 13.68 | 67.64 |
| 22.26 | 14.86 | 62.88 |
| 26.56 | 15.67 | 57.77 |
| 30.80 | 16.18 | 53.02 |
| 34.03 | 16.40 | 49.57 |
| 43.91 | 16.59 | 39.50 |
| 58.64 | 16.39 | 24.97 |
| 67.90 | 14.33 | 17.77 |
| 76.68 | 10.73 | 12.59 |
| 86.58 | 5.94 | 7.48 |
| 91.18 | 3.07 | 5.75 |
| 94.84 | — | 5.16 |

The distribution results at 20° are as follows:

| Gms. $CH_3COOH$ per 100 gms. | | $\frac{C_1}{C_2}$ | Gms. $CH_3COOH$ per 100 gms. | | $\frac{C_1}{C_2}$ |
|---|---|---|---|---|---|
| $H_2O$ layer ($C_1$) | $C_6H_5NH_2$ layer ($C_2$) | | $H_2O$ layer ($C_1$) | $C_6H_5NH_2$ layer ($C_2$) | |
| 1.68 | 0.65 | 2.58 | 5.22 | 3.11 | 1.68 |
| 2.15 | 0.92 | 2.33 | 6.82 | 4.33 | 1.57 |
| 3.05 | 1.51 | 2.02 | 8.77 | 6.22 | 1.45 |
| 4.65 | 2.56 | 1.82 | 9.63 | 7.25 | 1.33 |
| | | | 11.19 | 9.30 | 1.20 |

The authors also studied the equilibrium in this system as influenced by temperature. For this there was used, on the one hand a mixture of aniline and acetic acid of given concentration and on the other a mixture of water and acetic acid of the same concentration of acetic acid. Mixtures of these in any proportion give a ternary mixture of constant acetic acid concentration. Such ternary mixtures containing respectively 15.83, 16.56 percent $CH_3COOH$ were each found to have an upper and a lower critical solution temperature and thus yield a closed solubility curve. The explanation of this was considered to be the hydrolysis of the aniline acetate formed in solution.

The following additional determinations of the system Acetic Acid, Aniline and Water at 0° are given by Ust-Kachkintsev and Nertshin, 1936.

| Gms. per 100 gms. sat. solution | | |
|---|---|---|
| $C_6H_5NH_2$ | $CH_3COOH$ | $H_2O$ |
| 9.8 | 6.0 | 84.2 |
| 25.5 | 15.8 | 58.7 |
| 41.7 | 16.8 | 41.5 |
| 42.5 | 16.5 | 44.0 |
| 59.1 | 15.8 | 25.1 |
| 74.3 | 12.1 | 13.6 |

These authors also give results for the quarternary systems Acetic Acid, Aniline, Pyridine and Water and Acetic Acid, Aniline, Piperidine and Water at 0°.

### Distribution of Acetic Acid between Water and Chloroform:

#### At Room Temperature.

(Wright, Thomson and Leon — Proc. Roy. Soc. 49, 185, 1891.)

Results in parts per 100 parts of solution.

| Upper Layer. | | | Lower Layer. | | |
|---|---|---|---|---|---|
| $CH_3COOH$. | $CHCl_3$. | $H_2O$. | $CH_3COOH$. | $CHCl_3$. | $H_2O$. |
| 0 | 0.84 | 99.16 | 0 | 99.01 | 0.99 |
| 6.46 | 0.92 | 92.62 | 1.04 | 98.24 | 0.72 |
| 17.69 | 0.79 | 81.52 | 3.83 | 94.98 | 1.19 |
| 25.10 | 1.21 | 73.69 | 6.77 | 91.85 | 1.38 |
| 33.71 | 2.97 | 63.32 | 11.05 | 87.82 | 1.13 |
| 44.12 | 7.30 | 48.58 | 17.72 | 80.00 | 2.28 |
| 50.18 | 15.11 | 34.71 | 25.75 | 70.13 | 4.12 |

#### At 25°.

(Herz and Lewy; Rothmund and Wilsmore.)

| Gms. $CH_3COOH$ per 100 cc. | | G. M. $CH_3COOH$ per 100 cc. | |
|---|---|---|---|
| $H_2O$ Layer. | $CHCl_3$ Layer. | $H_2O$ Layer. | $CHCl_3$ Layer. |
| 2 | 0.089 | 0.05 | 0.0032 |
| 4 | 0.313 | 0.075 | 0.0062 |
| 6 | 0.596 | 0.100 | 0.0100 |
| 8 | 0.974 | 0.150 | 0.0198 |
| 10 | 1.430 | 0.175 | 0.0260 |
| 12 | 1.982 | 0.200 | 0.0325 |
| 20 | 5.10 | 0.30 | 0.070 |
| 30 | 10.2 | 0.50 | 0.170 |
| 40 | 15.3 | 0.70 | 0.275 |
| 50 | 21.9 | 0.80 | 0.335 |
| 52.3 | 39.54 | 0.87 | 0.659 |

See Note, page 106

In addition to the above results, data for somewhat lower concentrations of acetic acid determined at 20° are given by Dawson and Grant (1901).

Results showing the influence of electrolytes upon the distribution of acetic acid between water and chloroform are given by Rothmund and Wilsmore and by Dawson and Grant.

### Distribution of Acetic Acid at 25° between:

#### Water and Carbon Disulphide.

(Herz and Lewy.)

| Gms $CH_3COOH$ per 100 cc. | | G. M. $CH_3COOH$ per 100 cc. | |
|---|---|---|---|
| $H_2O$ Layer. | $CS_2$ Layer. | $H_2O$ Layer. | $CS_2$ Layer. |
| 65 | 2.64 | 1.1 | 0.45 |
| 70 | 3.0 | 1.2 | 0.55 |
| 75 | 3.3 | 1.2 | 0.80 |
| 80 | 5.4 | 1.35 | 0.97 |
| 85 | 6.4 | 1.4 | 1.3 |

#### Water and Carbon Tetrachloride.

(Herz and Lewy.)

| Gms. $CH_3COOH$ per 100 cc. | | G. M. $CH_3COOH$ per 100 cc. | |
|---|---|---|---|
| $H_2O$ Layer. | $CCl_4$ Layer. | $H_2O$ Layer. | $CCl_4$ Layer. |
| 30 | 1.8 | 0.5 | 0.03 |
| 40 | 3.0 | 0.7 | 0.055 |
| 50 | 4.8 | 0.9 | 0.095 |
| 60 | 5.8 | 1.1 | 0.155 |
| 70 | 12.0 | 1.2 | 0.235 |
| 76.2 | 25.2 | 1.27 | 0.420 |

Results for the distribution of acetic acid between water and mixtures of equal volumes of carbon disulfide and carbon tetrachloride at 25° are given by Herz and Kurzer (1910).

## Distribution of Acetic Acid at 25° between:

### Water and Bromoform.

(H. and L. — Z. electro. Ch. 11, 818, '05.)

| Gms. $CH_3COOH$ per 100 cc. | | G. M. $CH_3COOH$ per 100 cc. | |
|---|---|---|---|
| $H_2O$ Layer. | $CHBr_3$ Layer. | $H_2O$ Layer. | $CHBr_3$ Layer. |
| 20 | 1.5 | 0.4 | 0.035 |
| 30 | 3.0 | 0.6 | 0.070 |
| 40 | 4.8 | 0.8 | 0.120 |
| 50 | 7.8 | 1.0 | 0.20 |
| 60 | 12.0 | 1.1 | 0.28 |
| 65 | 15.6 | 1.15 | 0.395 |
| 70 | 27.0 | ... | ... |

See Note below

### Water and Toluene.

(H. and F. — Ber. 38, 1140, '05.)

| Gms. $CH_3COOH$ per 100 cc. | | G. M. $CH_3COOH$ per 100 cc. | |
|---|---|---|---|
| $H_2O$ Layer. | $C_6H_5CH_3$ Layer. | $H_2O$ Layer. | $C_6H_5CH_3$ Layer. |
| 5 | 0.119 | 0.1 | 0.0025 |
| 10 | 0.328 | 0.2 | 0.0075 |
| 20 | 1.132 | 0.4 | 0.0260 |
| 30 | 2.265 | 0.6 | 0.0530 |
| 40 | 3.725 | 0.8 | 0.090 |
| 50 | 5.841 | 1.0 | 0.140 |
| 60 | 8.344 | ... | ... |

## Distribution of Acetic Acid at 25° Between Water and Several Organic Solvents.

(Archibald, 1932.)

| Immiscible Solvents | Gm. Mols. $CH_3COOH$ per liter | | $\frac{C_2}{C_1}$ |
|---|---|---|---|
| | $H_2O$ layer ($C_1$) | Organic layer ($C_2$) | |
| Water and Ethyl Methyl Ketone | 0.14828 | 0.17866 | 1.2050 |
| " " " " " | 0.46045 | 0.54351 | 1.1804 |
| " " Tertiary Amyl Alcohol | 0.13205 | 0.19531 | 1.4971 |
| " " " " " | 0.37427 | 0.52829 | 1.4115 |
| " " Secondary Butyl Alcohol | 0.15100 | 0.19212 | 1.2723 |
| " " " " " | 0.46670 | 0.53182 | 1.1395 |
| " " Normal Butyl Alcohol | 0.15072 | 0.18757 | 1.2445 |
| " " " " " | 0.42054 | 0.51302 | 1.2200 |
| " " Normal Amyl Alcohol | 0.16451 | 0.15305 | 0.9303 |
| " " " " " | 0.48828 | 0.45864 | 0.9393 |

## Distribution of Acetic Acid between:

### Water and Amyl Alcohol at 20°.

(Herz and Fischer, 1904.)

| Gms. $CH_3COOH$ per 100 cc. | | G. M. $CH_3COOH$ per 100 cc. | |
|---|---|---|---|
| $H_2O$ Layer. | Alcoholic Layer. | $H_2O$ Layer | Alcoholic Layer. |
| 1 | 0.923 | 0.01 | 0.0095 |
| 2 | 1.847 | 0.03 | 0.0280 |
| 3 | 2.741 | 0.05 | 0.0460 |
| 4 | 3.694 | 0.07 | 0.0645 |
| 5 | 4.587 | 0.09 | 0.0830 |
| 6 | 5.475 | 0.11 | 0.1010 |
| 7 | 6.434 | 0.13 | 0.1190 |
| 8 | 7.328 | ... | ... |

### Water and Benzene at 25°.

(Herz and Fischer, 1905.)

| Gms. $CH_3COOH$ per 100 cc. | | G. M. $CH_3COOH$ per 100 cc. | |
|---|---|---|---|
| $H_2O$ Layer. | $C_6H_6$ Layer. | $H_2O$ Layer. | $C_6H_6$ Layer. |
| 5 | 0.130 | 0.05 | 0.0014 |
| 10 | 0.417 | 0.10 | 0.0005 |
| 20 | 1.55 | 0.20 | 0.0030 |
| 30 | 3.03 | 0.30 | 0.0290 |
| 40 | 4.95 | 0.50 | 0.051 |
| .. | ... | 0.70 | 0.090 |

Note. — The distribution results of Herz and co-workers are reported in millimolecules per 10 cc. portions of each layer in the several cases. To obtain the figures given in the tables here shown, the original results, before and after calculating to gram quantities, were plotted on cross-section paper, and from the curves thus obtained, readings for regular intervals of concentration of acetic acid in the aqueous layer were selected.

## Distribution of Acetic Acid between Water and Benzene.

(Waddell, 1898; see also Lincoln, 1904.)

The measurements were made by adding varying amounts of benzene or water to 5 cc. of acetic acid and then running in water or benzene till saturation was reached. The observed readings were calculated to grams per 100 grams of the liquid mixture.

| | Upper Layer. | | | Lower Layer. | | |
|---|---|---|---|---|---|---|
| t°. | $CH_3COOH$. | $C_6H_6$. | $H_2O$. | $CH_3COOH$. | $C_6H_6$. | $H_2O$. |
| 25 | 0.46 | 99.52 | 0.02 | 9.4 | 0.18 | 90.42 |
| 25 | 3.10 | 96.75 | 0.15 | 28.2 | 0.53 | 71.27 |
| 25 | 5.20 | 94.55 | 0.25 | 37.7 | 0.84 | 61.46 |
| 25 | 8.7 | 90.88 | 0.42 | 48.3 | 1.82 | 49.88 |
| 25 | 16.3 | 82.91 | 0.79 | 61.4 | 6.1 | 32.5 |
| 25 | 30.5 | 67.37 | 2.13 | 66.0 | 13.8 | 20.2 |
| 25 | 52.5 | 39.60 | 7.60 | 52.8 | 39.6 | 7.6 |
| 35 | 1.2 | 98.68 | 0.08 | 16.4 | 0.62 | 82.98 |
| 35 | 5.7 | 93.97 | 0.33 | 36.8 | 1.42 | 62.78 |
| 35 | 9.0 | 90.42 | 0.58 | 49.0 | 2.10 | 48.90 |
| 35 | 45.0 | 49.00 | 6.0 | 61.3 | 25.5 | 13.2 |
| 35 | 52.2 | 39.4 | 8.4 | 52.2 | 39.4 | 8.4 |

Additional data in connection with the distribution of acetic acid between water and benzene are given by King and Narracutt (1909), Kuriloff (1898), Farmer (1903), Bubanovic (1913), and Lincoln (1904). This latter investigator points out that the same degree of clouding does not represent the end point in all cases as was assumed by Waddell (1900).

Data for the distribution of acetic acid between benzene and aqueous solutions of sodium acetate at 25° are given by Farmer (1903).

## Distribution of Acetic Acid Between Water and Benzene.

(Bektourov, 1939.)

| Results at 0° | | | Results at 25° | | | Results at 60° | | |
|---|---|---|---|---|---|---|---|---|
| Gm. Equiv. $CH_3COOH$ per liter | | $\frac{C_1}{C_2}$ | Gm. Equiv. $CH_3COOH$ per liter | | $\frac{C_1}{C_2}$ | Gm. Equiv. $CH_3COOH$ per liter | | $\frac{C_1}{C_2}$ |
| $H_2O$ layer | $C_6H_6$ layer | | $H_2O$ layer | $C_6H_6$ layer | | $H_2O$ layer | $C_6H_6$ layer | |
| 0.3123 | 0.00387 | 82.6 | 0.7760 | 0.0199 | 39.0 | 0.9274 | 0.0346 | 26.6 |
| 0.6151 | 0.0113 | 54.4 | 1.0031 | 0.0284 | 35.3 | 1.4194 | 0.0661 | 21.5 |
| 1.3911 | 0.0416 | 33.4 | 1.2680 | 0.0417 | 30.4 | 1.8547 | 0.1230 | 15.1 |
| 2.4604 | 0.1072 | 22.96 | 2.6496 | 0.1325 | 20.0 | 3.3310 | 0.3020 | 11.0 |
| 3.9934 | 0.2555 | 15.6 | 4.0343 | 0.2792 | 14.4 | 3.9366 | 0.3785 | 10.4 |
| 5.6589 | 0.4542 | 12.5 | 5.6589 | 0.4731 | 12.0 | 3.7500 | 0.5299 | 8.96 |
| 7.2676 | 0.7570 | 9.60 | 7.7407 | 0.8233 | 9.4 | 4.7500 | 0.5299 | 8.96 |
| 9.7468 | 1.2775 | 7.63 | 8.9709 | 1.1639 | 7.71 | 6.4159 | 0.8237 | 7.70 |
| 11.7341 | 2.4604 | 4.77 | 10.1254 | 1.4951 | 6.77 | 8.7249 | 1.3437 | 6.49 |
| 12.7750 | 4.0785 | 3.13 | 12.2073 | 4.8640 | 2.51 | 10.7310 | 2.4414 | 4.40 |
| 11.8069 | 6.4443 | 1.83 | 11.1285 | 6.1131 | 1.82 | 11.6773 | 4.1069 | 2.84 |
| | | | | | | 11.605 | 5.6778 | 2.04 |

## Distribution of Acetic Acid Between Water and Chloroform.

(Bektourov, 1939.)

### Results at 0°

| Gm. Equiv. $CH_3COOH$ per liter | | $\frac{C_1}{C_2}$ |
|---|---|---|
| $H_2O$ layer ($C_1$) | $CHCl_3$ layer ($C_2$) | |
| 0.1773 | 0.00827 | 21.44 |
| 0.3901 | 0.0260 | 15.0 |
| 0.8984 | 0.1158 | 7.76 |
| 1.6548 | 0.3310 | 5.00 |
| 3.4517 | 1.0402 | 3.32 |
| 5.7214 | 2.1751 | 2.64 |
| 7.7776 | 3.5696 | 2.18 |
| 8.7239 | 4.3261 | 2.02 |
| 9.4804 | 5.3194 | 1.78 |

### Results at 50°

| Gm. Equiv. $CH_3COOH$ per liter | | $\frac{C_1}{C_2}$ |
|---|---|---|
| $H_2O$ layer ($C_1$) | $CHCl_3$ layer ($C_2$) | |
| 0.0709 | 0.00355 | 20.0 |
| 0.1891 | 0.0118 | 16.0 |
| 0.2482 | 0.0189 | 13.1 |
| 0.9109 | 0.1300 | 7.0 |
| 2.1987 | 0.4610 | 4.77 |
| 4.3028 | 1.3000 | 3.31 |
| 6.5015 | 2.3642 | 2.75 |
| 8.0619 | 3.3808 | 2.38 |
| 9.3386 | 4.8702 | 1.92 |

## Distribution of Acetic Acid Between Water and Carbon Tetrachloride.

(Bektourov, 1939.)

### Results at 25°

| Gm. Equiv. $CH_3COOH$ per liter | | $\frac{C_1}{C_2}$ |
|---|---|---|
| $H_2O$ layer ($C_1$) | $CCl_4$ layer ($C_2$) | |
| 0.0733 | 0.000945 | 77.6 |
| 1.0284 | 0.0260 | 39.6 |
| 1.8560 | 0.0709 | 26.2 |
| 2.6952 | 0.1418 | 19.0 |
| 3.5699 | 0.2128 | 16.8 |
| 4.9412 | 0.3664 | 13.5 |
| 7.7546 | 0.7447 | 10.4 |
| 10.2370 | 1.3358 | 7.66 |
| 11.1354 | 1.7022 | 6.54 |

### Results at 60°

| Gm. Equiv. $CH_3COOH$ per liter | | $\frac{C_1}{C_2}$ |
|---|---|---|
| $H_2O$ layer ($C_1$) | $CCl_4$ layer ($C_2$) | |
| 0.1182 | 0.00236 | 50.1 |
| 0.5437 | 0.0142 | 38.3 |
| 0.8275 | 0.02719 | 30.4 |
| 1.6786 | 0.0874 | 19.2 |
| 3.0262 | 0.2009 | 15.1 |
| 7.4945 | 0.7093 | 10.6 |
| 9.5514 | 1.1466 | 8.33 |
| 10.8517 | 1.6786 | 6.46 |
| 11.4191 | 1.9859 | 5.75 |

## Distribution of Acetic Acid Between :

### Water and Benzene at 25°

(Brown and Bury, 1923.)

| Gms. mols. $CH_3COOH$ per liter of | |
|---|---|
| $H_2O$ layer. | $C_6H_6$ layer. |
| 0.531 | 0.0125 |
| 0.633 | 0.0165 |
| 1.148 | 0.0443 |
| 1.510 | 0.0714 |
| 1.858 | 0.1015 |
| 2.976 | 0.224 |
| 4.743 | 0.486 |
| 5.444 | 0.614 |
| 6.101 | 0.739 |
| 7.546 | 1.089 |
| 8.710 | 1.463 |
| 10.812 | 2.692 |
| 11.137 | 3.111 |

### Water and Epichlorhydrine at 10°

(Leone and Benelli, 1922.)

| Gms. $CH_3COOH$ per 100 gms. of | | $\frac{a}{b}$. |
|---|---|---|
| upper layer ($a$). | lower layer ($b$). | |
| 3.47 | 1.07 | 3.22 |
| 6.71 | 2.29 | 2.93 |
| 9.47 | 3.59 | 2.63 |
| 12.02 | 5.00 | 2.40 |
| 16.58 | 7.72 | 2.17 |
| 20.00 | 10.00 | 2.00 |
| 23.70 | 13.21 | 1.75 |
| 26.43 | 16.59 | 1.63 |
| 27.45 | 18.00 | 1.52 |
| 29.25 | 21.83 | 1.34 |
| 30.10 | 23.33 | 1.29 |
| 29.07 | 24.97 | 1.16 |
| 28.50 | 25.33 | 1.12 |

## ACETIC ACID

### Distribution of Acetic Acid Between the Conjugate Layers Formed with Water and Benzene at 25°.

(Hand, 1930.

The binodal curve was determined by titrating mixtures of two of the liquids with the third to an end point which was the mean of the amount which was unmistakably insufficient to produce clouding and that which was definitely in excess. The tie lines were determined by mixing sufficient quantities of the three liquids to yield two layers, and after attainment of equilibrium at 25°, about 2 gram quantities of each layer were removed, weighed and titrated for acetic acid with standard barium hydroxide.

Results for the Binodal Curve

| Gms. present in the homogeneous mixture | | | Gms. present in the homogeneous mixture | | |
|---|---|---|---|---|---|
| $CH_3COOH$ | $C_6H_6$ | $H_2O$ | $CH_3COOH$ | $C_6H_6$ | $H_2O$ |
| 37.46 | 9.30 | 9.985 | 10.47 | 0.15 | 29.83 |
| 36.26 | 7.09 | 10.86 | 20.54 | 1.50-1.61 | 11.20 |
| 30.88 | 14.43 | 5.87 | 20.57 | 0.98-1.06 | 15.89 |
| 33.2 | 16.56 | 6.04 | 20.32-20.45 | 28.38 | 1.83 |
| 31.29 | 4.10 | 12.16 | 20.80 | 0.89-0.90 | 17.59 |
| 36.39 | 6.44 | 11.64 | 20.83 | 2.09-2.14 | 9.74 |
| 36.74 | 22.23 | 5.89 | 10.09-10.21 | 11.04 | 1.11 |
| 26.10 | 17.53 | 4.13 | 9.85 | 8.23 | 1.31-1.36 |
| 30.88 | 17.66 | 5.38 | 10.45-10.85 | 19.50 | 0.717 |
| 20.23 | 0.48 | 30.16 | 10.19-10.33 | 31.53 | 0.404 |
| 14.21 | 0.21 | 29.98 | 52.3 | 40.5 | 7.2 PP. |

Results for the Tie Lines

Upper Layer

| Gms. per 100 gms. solution | | |
|---|---|---|
| $CH_3COOH$ | $C_6H_6$ | $H_2O$ |
| 0.15 | 99.849 | 0.001 |
| 1.4 | 98.56 | 0.04 |
| 3.27 | 96.62 | 0.11 |
| 13.3 | 86.4 | 0.4 |
| 15.0 | 84.5 | 0.5 |
| 19.9 | 79.4 | 0.7 |
| 22.8 | 76.35 | 0.85 |
| 31.0 | 67.1 | 1.0 |
| 35.3 | 62.2 | 2.5 |
| 37.8 | 59.2 | 3.0 |
| 44.7 | 50.7 | 4.6 |
| 52.3 | 40.5 | 7.2 |

Lower Layer

| Gm. per 100 gms. solution | | |
|---|---|---|
| $CH_3COOH$ | $C_6H_6$ | $H_2O$ |
| 4.56 | 0.04 | 95.2 |
| 17.7 | 0.20 | 82.1 |
| 29.0 | 0.40 | 70.6 |
| 56.9 | 3.3 | 39.8 |
| 59.2 | 4.0 | 36.8 |
| 63.9 | 6.5 | 29.6 |
| 64.8 | 7.7 | 27.5 |
| 65.8 | 18.1 | 16.1 |
| 64.5 | 21.1 | 14.4 |
| 63.4 | 23.4 | 13.2 |
| 59.3 | 30.0 | 10.7 |
| 52.3 | 40.5 | 7.2 P.P. |

P.P. = Plait Point

Data showing the solubility of water in benzene as influenced by the presence of acetic and other fatty acids are given by Briegleb, 1930.

### Distribution of Acetic Acid Between Water and Ethylether.

(Löfman, 1919.)

The author points out the discrepancies in previous determinations. In his experiments equal volumes of the two liquids were shaken together for one-half hour at constant temperature and each layer analyzed by titration, using phenolphthalein as indicator. Acetic acid forms double molecules in ether.

| | Gms. mols. $CH_3COOH$ per liter. | | | | Gms. mols. $CH_3COOH$ per liter. | | |
|---|---|---|---|---|---|---|---|
| t° | $H_2O$ layer ($C_1$). | Ether layer ($C_2$). | $\frac{C_1}{C_2}$. | t°. | $H_2O$ layer ($C_1$). | Ether layer ($C_2$). | $\frac{C_1}{C_2}$. |
| 0... | 0 01273 | 0.00684 | 1.86 | 25... | 0.01323 | 0.006097 | 2.17 |
| 0... | 0.03122 | 0.01667 | 1.87 | 25... | 0.03309 | 0.01528 | 2.17 |
| 0... | 0.06292 | 0.03401 | 1.85 | 25... | 0.06654 | 0.0311 | 2.14 |
| 0... | 0.1262 | 0.06971 | 1.81 | 25... | 0.1341 | 0.06355 | 2.11 |
| 0... | 0.3130 | 0.1809 | 1 73 | 25... | 0.3265 | 0.1624 | 2.01 |
| 0... | 0.6230 | 0.3829 | 1.62 | 25... | 0.6497 | 0.3406 | 1.91 |
| 0... | 1.1930 | 0.8145 | 1.45 | 25... | 1.2600 | 0.7413 | 1.70 |

Similar determinations are also given for 5°, 10°, 15° and 20°. — Additional data at 15° are given by Pinnow, 1922: at 20-22° by Behrens, 1926; at 25° by Smith 1921-2.

### Distribution of Acetic Acid between Water and Ethyl Ether.

(de Kolossovsky, 1911.)

Results at Several Temperatures.

| | Gms. $CH_3COOH$ per 100 cc. of: | | |
|---|---|---|---|
| t°. | $H_2O$ Layer ($p$). | Ether Layer ($p'$). | $\frac{p}{p'}$. |
| 13 | 0.365 | 0.207 | 1.76 |
| 18 | 0.367 | 0.201 | 1.82 |
| 27 | 0.379 | 0.195 | 1.94 |
| 7.5 | 0.799 | 0.551 | 1.45 |
| 12 | 0.803 | 0.529 | 1.52 |
| 18 | 0.802 | 0.501 | 1.60 |
| 25 | 0.789 | 0.474 | 1.66 |

Results at 18°.

| Gms. $CH_3COOH$ per 100 cc. of: | | |
|---|---|---|
| $H_2O$ Layer ($p$). | Ether Layer ($p'$). | $\frac{p}{p'}$. |
| 1.0 | 0.5 | 2.0 |
| 2.0 | 1.0 | 2.0 |
| 4.0 | 2.1 | 1.9 |
| 6.0 | 3.5 | 1.7 |
| 8.0 | 4.9 | 1.6 |
| 10.0 | 6.6 | 1.5 |
| 15.0 | 11.4 | 1.3 |
| 20.0 | 17.0 | 1.2 |
| 25.0 | 23.3 | 1.07 |

According to results obtained at 25° by Morgan and Benson (1907), the ratio of distribution for concentrations of acetic acid up to 12 grams per 100 cc. of the $H_2O$ layer is more nearly constant (1.92) than shown above for 18°. A similar constancy of distribution (approx. 2.08 at 15°) was also found by Pinnow (1915).

Results showing the influence of varying concentrations of a large number of electrolytes upon the distribution of acetic acid between water and ether are given by de Kolossovsky, Dubrisay (1912), and by Hantzsch and Vagt (1901).

Data for the distribution of acetic acid between ether and molten $CaCl_2.6H_2O$ and ether and molten $LiNO_3 3H_2O$ are given by Morgan and Benson (1907).

One determination of the distribution of acetic acid between sat. aq. $CaCl_2$ solution (20 gms. per l.) and kerosene gave 97.7 gms. acid per 100 gms. aq. layer and 27 gms. per 100 gms. kerosene layer at ordinary temperature. (Crowell, 1918.)

## Distribution of Acetic Acid Between Water and Toluene at 25°.

(Woodman, 1926.)

Mixtures of weighed amounts of water and toluene were titrated with glacial acetic acid untill only a slight turbidity remained after shaking. The mixture was then placed in a thermostat and the titration continued to homogeneity.

| Gms. per 100 gms. sat. solution. | | Gms. per 100 gms. sat. solution. | | Gms. per 100 gms. sat. solution. | | Gms. per 100 gms. sat. solution. | |
|---|---|---|---|---|---|---|---|
| $H_2O$. | $C_6H_5CH_3$. | $H_2O$. | $C_6H_5CH_3$. | $H_2O$. | $C_6H_5CH_3$. | $H_2O$. | $C_6H_5CH_3$. |
| 0.4721 | 81.3979 | 10.82 | 22.34 | 14.50 | 14.62 | 25.30 | 5.454 |
| 1.474 | 66.866 | 11.53 | 19.89 | 16.00 | 12.54 | 25.80 | 5.308 |
| 2.966 | 55.124 | 11.93 | 19.30 | 17.10 | 11.32 | 26.52 | 5.02 |
| 4.594 | 45.84 | 12.02 | 19.48 | 18.00 | 10.29 | 28.13 | 4.446 |
| 4.689 | 44.72 | 12.38 | 18.37 | 20.08 | 8.662 | 33.42 | 2.975 |
| 6.871 | 35.38 | 12.83 | 17.43 | 21.76 | 7.415 | 43.89 | 1.419 |
| 8.507 | 29.27 | 12.98 | 17.53 | 23.23 | 6.342 | 57.597 | 0.6533 |
| 9.809 | 25.28 | 13.56 | 16.07 | 24.34 | 5.97 | 67.8344 | 0.2856 |

In order to locate the points (tie lines) corresponding to upper and lower liquid layers, mixtures of the three components, yielding two layers, were brought to equilibrium in a thermostat and measured volumes of each layer weighed and titrated for acetic acid. The following results were obtained.

| Aqueous layer. | | Toluene layer. | | Aqueous layer. | | Toluene layer. | |
|---|---|---|---|---|---|---|---|
| $d\frac{25}{4}$. | wt. % $CH_3COOH$. | $d\frac{25}{4}$ | wt. % $CH_3COOH$ | $d\frac{25}{4}$. | wt. % $CH_3COOH$. | $d\frac{25}{4}$. | wt. % $CH_3COOH$. |
| 1.025 | 21.38 | 0.8614 | 1.374 | 1.049 | 67.70 | 0.8847 | 18.55 |
| 1.035 | 30.87 | 0.8630 | 2.797 | 1.044 | 69.71 | 0.8846 | 21.50 |
| 1.042 | 37.69 | 0.8650 | 4.072 | 1.039 | 70.55 | 0.8952 | 24.88 |
| 1.050 | 47.50 | 0.8676 | 6.363 | 1.024 | 69.85 | 0.9099 | 32.96 |
| 1.054 | 58.05 | 0.8730 | 10.35 | 1.006 | 66.68 | 0.9276 | 40.64 |
| 1.052 | 64.86 | 0.8796 | 14.98 | 0.9757 | 58.46 | 0.9588 | 53.07 |

## Distribution of Acetic Acid at 25° Between:

(de Kolossowsky, 1934; de Kolossowsky, Kulikow and Bekturov, 1935.)

### Water and Nitro Benzene

| Gm. Mols. $CH_3COOH$ per liter | | $\frac{C_1}{C_2}$ |
|---|---|---|
| $H_2O$ layer ($C_1$) | $C_6H_5NO_2$ layer ($C_2$) | |
| 0.178 | 0.0075 | 23.7 |
| 0.515 | 0.0248 | 20.8 |
| 0.842 | 0.0468 | 18.0 |
| 1.684 | 0.131 | 12.85 |
| 2.414 | 0.234 | 10.32 |
| 4.116 | 0.543 | 7.58 |
| 5.314 | 0.805 | 6.60 |
| 7.881 | 1.581 | 4.98 |
| 9.337 | 2.510 | 3.72 |
| 9.880 | 3.690 | 2.68 |
| 9.488 | 5.095 | 1.86 |

### Water and o Nitro Toluene

| Gm. Mols. $CH_3COOH$ per liter | | $\frac{C_1}{C_2}$ |
|---|---|---|
| $H_2O$ layer ($C_1$) | o $C_6H_4CH_3NO_2$ layer ($C_2$) | |
| 0.1418 | 0.0049 | 28.9 |
| 0.2955 | 0.0108 | 27.4 |
| 1.1075 | 0.0539 | 20.55 |
| 1.657 | 0.0969 | 17.1 |
| 2.860 | 0.216 | 13.06 |
| 3.889 | 0.366 | 10.63 |
| 5.449 | 0.612 | 8.90 |
| 6.919 | 0.808 | 7.71 |
| 8.717 | 1.422 | 6.15 |
| 10.827 | 3.581 | 3.02 |
| 9.752 | 5.987 | 1.63 |

### Distribution of Acetic Acid at 25° Between Water and Toluene.

(de Kolossowsky and Megenine, 1932.)

| Gm. Equiv. $CH_3COOH$ per liter | | $\frac{C_1}{C_2}$ | Gm. Equiv. $CH_3COOH$ per liter | | $\frac{C_1}{C_2}$ |
|---|---|---|---|---|---|
| $H_2O$ layer ($C_1$) | $C_6H_5CH_3$ layer ($C_2$) | | $H_2O$ layer ($C_1$) | $C_6H_5CH_3$ layer ($C_2$) | |
| 0.9624 | 0.03758 | 25.61 | 7.1623 | 0.8377 | 8.55 |
| 1.8963 | 0.10373 | 18.28 | 8.782 | 1.218 | 7.21 |
| 2.8072 | 0.1928 | 14.56 | 10.256 | 1.744 | 5.88 |
| 3.7041 | 0.2959 | 12.52 | 11.473 | 2.527 | 4.51 |
| 4.5840 | 0.4160 | 11.02 | 12.190 | 3.810 | 3.20 |
| 5.4393 | 0.5670 | 9.70 | 12.5 | 12.5 | 1.0 |

### Distribution of Acetic Acid at 25° between:

#### Water and *o* or *p* Xylene.

(Herz and Fischer.)

| Gms. $CH_3COOH$ per 100 cc. | | G. M. $CH_3COOH$ per 100 cc. | |
|---|---|---|---|
| $H_2O$ Layer. | *o* or *p* Xylene Layer. | $H_2O$ Layer. | *o* or *p* Xylene Layer. |
| 5 | 0.24 | 0.1 | 0.004 |
| 10 | 0.48 | 0.2 | 0.010 |
| 20 | 1.13 | 0.4 | 0.025 |
| 30 | 2.15 | 0.6 | 0.047 |
| 40 | 3.40 | 0.8 | 0.079 |
| 50 | 5.10 | 1.0 | 0.122 |
| 60 | 7.27 | 1.2 | 0.230 |
| 70 | 12.52 | ... | ... |

#### Water and *m* Xylene.

(Herz and Fischer.)

| Gms. $CH_3COOH$ per 100 cc. | | G. M. $CH_3COOH$ per 100 cc. | |
|---|---|---|---|
| $H_2O$ Layer. | *m* Xylene Layer. | $H_2O$ Layer. | *m* Xylene Layer. |
| 5 | 0.06 | 0.1 | 0.0015 |
| 10 | 0.30 | 0.2 | 0.007 |
| 20 | 0.95 | 0.4 | 0.022 |
| 30 | 1.91 | 0.6 | 0.042 |
| 40 | 3.04 | 0.8 | 0.072 |
| 50 | 4.65 | 1.0 | 0.111 |
| 60 | 6.65 | 1.2 | ... |

See Note, page 106

### Distribution of Acetic Acid at 20° Between Water and Iso Propyl Ether.

(Smith and Elgin, 1935.)

| Gm. Mols. $CH_3COOH$ per liter | | $\frac{C_2}{C_1}$ | Gm. Mols. $CH_3COOH$ per liter | | $\frac{C_2}{C_1}$ |
|---|---|---|---|---|---|
| $H_2O$ layer ($C_1$) | Ether layer ($C_2$) | | $H_2O$ layer ($C_1$) | Ether layer ($C_2$) | |
| 0.0732 | 0.0136 | 0.185 | 0.8900 | 0.1733 | 0.196 |
| 0.0785 | 0.0140 | 0.178 | 1.1070 | 0.2290 | 0.207 |
| 0.1450 | 0.0254 | 0.177 | 1.3600 | 0.2803 | 0.206 |
| 0.2980 | 0.0560 | 0.188 | 1.4300 | 0.3260 | 0.228 |
| 0.3030 | 0.0577 | 0.190 | 1.7970 | 0.3994 | 0.222 |
| 0.6025 | 0.1186 | 0.196 | 2.7800 | 0.6740 | 0.242 |
| 0.6925 | 0.1430 | 0.206 | | | |

Iso Propyl Ether = $(CH_3)_2CHOCH(CH_3)_2$.

A method for the determination of the composition of mixtures of fatty acids, based upon their relative distribution between water and iso propyl ether is described by Werkman, 1930. A table of results for the distribution constants of mixtures of varying proportions of pairs of formic, acetic, proprionic, butyric and lactic acids between water and iso propyl ether at 25° is given.

## Distribution of Acetic Acid at Room Temperature Between Water and Petroleum Ether.

(Grossfeld and Miermeister, 1932.)

| cc 0.1 n NaOH required for the $CH_3COOH$ in 25 cc of: | | cc 0.1 n NaOH required for the $CH_3COOH$ in 25 cc of: | |
|---|---|---|---|
| $H_2O$ layer | Pet. Ether layer | $H_2O$ layer | Pet. Ether layer |
| 6.6 | 0.030 | 46.7 | 0.080 |
| 13.6 | 0.045 | 97.8 | 0.228 |
| 22.6 | 0.056 | 172.4 | 0.608 |
| | | 242.3 | 1.220 |

## Distribution of Acetic Acid at 25° Between:

(Gordon and Reid, 1922.)

Water and Cotton Seed Oil.

| Gms. $CH_3COOH$ per 100 gms. | | Gms. $CH_3COOH$ per 100 gms. | | Gms. $CH_3COOH$ per 100 gms. | | Gms. $CH_3COOH$ per 100 gms. | |
|---|---|---|---|---|---|---|---|
| $H_2O$ layer. | C. S. oil layer. | $H_2O$ layer. | C. S. oil layer | $H_2O$ layer. | C. S. oil layer. | $H_2O$ layer. | Kerosene layer. |
| 1.9 | 0.0525 | 12.7 | 0.435 | 46.9 | 2.34 | 9.1 | 0.0676 |
| 2.1 | 0.0544 | 14.1 | 0.494 | 50.9 | 2.76 | 17.0 | 0.189 |
| 2.4 | 0.0698 | 16.1 | 0.583 | 62.1 | 3.94 | 27.2 | 0.445 |
| 7.5 | 0.239 | 28.9 | 1.22 | 70.2 | 5.37 | 46.9 | 1.145 |
| 8.2 | 0.267 | 31.8 | 1.34 | 81.8 | 9.70 | 59.2 | 1.915 |

Water and Kerosene.

## Distribution of Acetic Acid Between Water and Olive Oil.

(Bodansky, 1928; Bodansky and Meigs, 1932.)

Results at 25°

| Gm. Mols. $CH_3COOH$ per liter | | $\frac{C_1}{C_2}$ |
|---|---|---|
| $H_2O$ layer ($C_1$) | Oil layer ($C_2$) | |
| 0.0102 | 0.0001 | 102.0 |
| 0.0492 | 0.0012 | 41.0 |
| 0.0960 | 0.0050 | 19.2 |
| 0.1970 | 0.0094 | 20.9 |

Results at 37.5°

| Gm. Mols. $CH_3COOH$ per liter | | $\frac{C_1}{C_2}$ |
|---|---|---|
| $H_2O$ layer ($C_1$) | Oil layer ($C_2$) | |
| 0.0102 | 0.0001 | 102.0 |
| 0.0492 | 0.0012 | 41.0 |
| 0.0962 | 0.0054 | 17.8 |
| 0.1930 | 0.0096 | 20.1 |

Data showing effect of camphor on the reciprocal solubility of acetic acid and olive oil are given by Wingard, 1917.

## Distribution of Acetic Acid Between Water and Collodion.

(Northrop, 1929.)

| Gm. Mols. $CH_3COOH$ per liter of | | $\frac{C_2}{C_1}$ |
|---|---|---|
| $H_2O$ layer ($C_1$) | Collodion layer ($C_2$) | |
| 0.01 | 0.01 | 1.0 |
| 0.10 | 0.099 | 1.0 |
| 1.00 | 0.87 | 0.87 |
| 5.00 | 3.05 | 0.61 |

Results are also given for the distribution of acetic acid between aqueous sodium acetate solution and collodion

### Distribution of Acetic Acid Between Aqueous Sodium Acetate Solutions and Ethylether at 20°. (Löfman, 1919.)

| Concentration of $CH_3COOH$. | Distribution Coefficient $\frac{C_1}{C_2}\left(\frac{\text{G. M. } CH_3COOH \text{ per liter Aq. layer}}{\text{G. M. } CH_3COOH \text{ per liter Ether layer}}\right)$ In | | | |
|---|---|---|---|---|
| | 0.0 normal $CH_3COONa$ (=$H_2O$). | 1.0 normal $CH_3COONa$ sol. | 2.0 normal $CH_3COONa$ sol. | 3.0 normal $CH_3COONa$ sol. |
| 0.0200 normal.. | 2.10 | 2.07 | 2.15 | 2.25 |
| 0.03125 » .. | 2.10 | 2.15 | 2.15 | 2.25 |
| 0.0625 » .. | 2.09 | 2.23 | 2.24 | 2.34 |
| 0.125 » .. | 2.04 | 2.25 | 2.24 | 2.36 |
| 0.25 » .. | 2.00 | 2.20 | 2.30 | 2.42 |
| 0.50 » .. | 1.92 | 2.16 | 2.21 | 2.33 |
| 1.00 » .. | 1.71 | 1.97 | 2.17 | 2.27 |
| 2.00 » .. | 1.45 | 1.70 | 2.00 | 2.18 |

Results showing the distribution of acetic acid between aqueous salt solutions and benzene at 35° are given by Mittra, 1928.

### Distribution of Acetic Acid Between Acetone and Glycerol at 25°.

(Smith, 1921-22.)

| Millimols. $CH_3COOH$ per liter In | | | Millimols. $CH_3COOH$ per liter In | | |
|---|---|---|---|---|---|
| Glycerol layer (G). | Acetone layer (A). | $\frac{A}{G}$. | Glycerol layer (G). | Acetone layer (A). | $\frac{A}{G}$. |
| 0.9425 | 1.725 | 1.83 | 3.875 | 7.00 | 1.81 |
| 1.00 | 1.825 | 1.82 | 4.60 | 8.20 | 1.78 |
| 1.60 | 3.025 | 1.80 | 4.85 | 8.60 | 1.77 |
| 2.77 | 4.70 | 1.70 | 10.00 | 17.60 | 1.76 |
| 2.775 | 4.775 | 1.72 | 17.30 | 29.30 | 1.69 |

Data for the distribution of mixtures of *Acetic Acid* and *Hydrogen Peroxide* between water and amyl alcohol, and between water and ether are given by Perschke and Tschufaroff, 1926. They also give results for the distribution of these compounds determined separately, which agree with those of Herz and Fischer, 1904-05, and Calvert 1901

### Distribution of Acetic Acid Between 2.2.4-Trimethyl Pentane (i Octane) and β Methoxy Ethanol.

(Henriques, 1933.)

Results at -19.5°

| Gm. Mols. $CH_3COOH$ per liter | | $\frac{1}{2}$ |
|---|---|---|
| Pentane layer (1) | Ethanol layer (2) | |
| 0.0013 | 0.1709 | 0.0078 |
| 0.0029 | 0.3743 | 0.0077 |
| 0.0064 | 0.6652 | 0.0096 |

Results at 0°

| Gm. Mols. $CH_3COOH$ per liter | | $\frac{1}{2}$ |
|---|---|---|
| Pentane layer (1) | Ethanol layer (2) | |
| 0.0033 | 0.1563 | 0.021 |
| 0.0046 | 0.1613 | 0.028 |
| 0.0084 | 0.3619 | 0.023 |
| 0.0105 | 0.3302 | 0.032 |
| 0.0169 | 0.6212 | 0.027 |

## Equilibrium in the System Acetic Acid and Pyridine.

(Sweringen and Ross, 1934.)

Mixtures of the two compounds contained in small sealed glass tubes were frozen and after removing from the freezing bath the point was determined at slowly rising temperature at which the last crystal disappeared in the melted mixture.

| t° | | Mol. Percent $CH_3COOH$ in Mixture | Solid Phase |
|---|---|---|---|
| -43.5 | | 0.00 | $C_5H_5N$ |
| -47.1 | | 6.345 | " |
| -50.6 | | 12.566 | " |
| -55.3 | | 18.529 | " |
| -62.3 | | 24.359 | " |
| -67.5 | Eutec. | 29.943 | " + $C_5H_5N.CH_3COOH$ |
| -57.4 | | 35.225 | $C_5H_5N.CH_3COOH$ |
| -51.6 | | 40.268 | " |
| -48.6 | | 45.440 | " |
| -48.2 | m. pt. | 50.004 | " |
| -49.1 | | 54.890 | " |
| -52.3 | | 59.594 | " |
| -56.7 | | 63.927 | " |
| -59. | Eutec. | 66.0 | " + $C_5H_5N.4CH_3COOH$ |
| -52.9 | | 68.202 | $C_5H_5N.4CH_3COOH$ |
| -47.5 | | 72.438 | " " |
| -44.5 | tr.pt. | 74.790 | " + $CH_3COOH$ |
| -31.8 | | 76.256 | $CH_3COOH$ |
| -26.9 | | 77.722 | " |
| -17.7 | | 80.771 | " |
| - 9.2 | | 83.720 | " |
| - 5.9 | | 84.773 | " |
| 0.0 | | 86.790 | " |
| + 3.7 | | 88.568 | " |
| 6.6 | | 90.710 | " |
| 10.95 | | 94.834 | " |
| 16.3 | | 100.000 | " |

## Reciprocal Solubility of Acetic Acid and Aniline.

(O' Connor, 1921.)

The freezing-point method could not be used in all cases and saturated solutions in contact with large amounts of solid at definite temperatures were prepared. These were analyzed by titrating the acetic acid in weighed portions and calculating the aniline by difference. The determinations were plotted and the following results read from the curve.

| t°. | Mols. $CH_3COOH$ per 100 mols. sat. sol. | Solid Phase. |
|---|---|---|
| 16.6.... | 100.0 | $CH_3COOH$ |
| 15.0.... | 97.0 | » |
| 10.0.... | 91.5 | » |
| 5.0. .. | 88.2 | » |
| 0.0.... | 85.5 | » |
| — 2.4 tr. pt. | 84.2 | $CH_3COOH + C_6H_5NH_2.2CH_3COOH$ |
| — 5.0.... | 83.5 | $CH_3COOH$ (unstable) |
| —10.0.... | 81.8 | » » |
| —15.0.... | 80.4 | » » |
| —18.2.... | 79.7 | » » |
| — 8.0.... | 85.5 | $C_6H_5NH_2.2CH_3COOH$ (unstable) |
| — 5.0.... | 84.7 | » » |
| 0.0.... | 83.3 | » |
| + 5.0.... | 81.5 | » |
| 10.0.... | 79.0 | » |
| 16.7 (crit. t.) | 67.0 | $C_6H_5NH_2.2CH_3COOH$ |
| 10.0.... | 46.5 | » |
| 5.0.... | 38.7 | » |
| 0.0.... | 32.2 | » |
| — 5.0.... | 27.0 | » |
| —10.0.... | 22.5 | » |
| —15.6 tr.pt.. | 18.2 | » + $C_6H_5NH_2$ |
| —17.0.... | 17.5 | $C_6H_5NH_2.2CH_3COOH$ (unstable) |
| —20.0.... | 40.0 | $C_6H_5NH_2$ (unstable) |
| —17.5.... | 22.0 | » » |
| —15.0.... | 16.5 | » |
| —12.5.... | 11.0 | » |
| —10.0.... | 6.5 | » |
| — 7.5.... | 2.2 | » |
| — 6.0.... | 0.0 | » |

More recent determinations especially of the unstable regions, are given by Puschin and Rikovski, 1932(a).

### Equilibrium in the System Acetic Acid and Nitrosobenzene.

(Hammick and Illingworth, 1930.)

The synthetic, sealed tube, method was used and the end point taken as that at which the last small trace of solid just failed to disappear.

| t° | Mol. Percent $C_6H_5NO$ in Mixture | Solid Phase | t° | Mol. Percent $C_6H_5NO$ in Mixture | Solid Phase |
|---|---|---|---|---|---|
| 16.3 | 0.0 | $CH_3COOH$ | 52.0 | 39.57 | $C_6H_5NO$ |
| 16 Eutec. | 7.0 | " + $C_6H_5NO$ | 57.7 | 55.31 | " |
| 27.5 | 11.06 | $C_6H_5NO$ | 58.5 | 58.82 | " |
| 41.0 | 20.49 | " | 62.0 | 69.42 | " |
| 47.0 | 29.16 | " | 68.5 | 100.00 | " |

### Solubility of Acetic Acid in Carbon Disulfide, Cyclohexane and in Petroleum. (Jones, 1923.)

The synthetic method was used and attention was directed particularly to the region of the critical solution temperature. The author was interested in the effect of small amounts of water upon the critical solution temperature and the use of this data as a criterion of purity of acetic acid. In addition to the results for pure acetic acid he gives data for the change in C. S. T. caused in each case by increasing amounts of water.

| $CH_3COOH + CS_2$. | | $CH_3COOH + C_6H_{12}$. | | $CH_3COOH$ + Petroleum (b. pt. 185°-195°). | |
|---|---|---|---|---|---|
| Miscibility temp. | Gms. $CH_3COOH$ per 100 gms. sat. sol. | Miscibility temp. | Gms. $CH_3COOH$ per 100 gms. sat. sol. | Miscibility temp. | Gms. $CH_3COOH$ per 100 gms. sat. sol. |
| 0.5 | 19.6 | 1.0 | 34.5 | 22.9 | 25.54 |
| 3.9* | 42.7 | 3.2 | 42.3 | 36.2 | 26.92 |
| 2.9 | 56.1 | 4.2* | 54.6 | 47.2 | 41.0 |
| 2 6 | 24.6 | 2.8 | 67.03 | 49.85 | 52.72 |
| 3.9 | 49.3 | —2.8 | 76.0 | 50.15* | 56.91 |
| —5.2 | 66.1 | | | 50.5* | 65.57 |
| | | | | 48.9 | 73.5 |
| | | | | 39.6 | 82 51 |
| | | | | 25.6 | 88.51 |

* Denotes critical solution temp.

### Solubility of Acetic Acid in Cotton Seed Oil and in Kerosene and Vice Versa. (Gordon and Reid, 1922.)

The mixtures were constantly shaken at 25° for four hours. After separation of the two layers the acetic acid in weighed amounts of each was determined by titration. The weight of oil was calculated by difference.

| | | | | |
|---|---|---|---|---|
| 100 gms. | Cotton Seed Oil | dissolve | 55.7 gms. | $CH_3COOH$ at 25° |
| » | Kerosene | » | 21.77 gms. | » |
| » | Anhydrous acetic acid | » | 5.6 gms. | Cotton Seed Oil at 25° |
| » | » | » | 12.5 gms. | Kerosene at 25° |

## ACETIC ACID

Freezing-point data are given for mixtures of Acetic Acid and each of the following compounds:

Acetamide (25)
Acetic Anhydride (8)
Aniline (21)(23)
Azobenzene (22)(31)
Benzamide (25)
Benzene (3)(9)(10)(11) (12)(13)(14)
Benzene + Water (10)
Benzene + Naphthalene (11)
Benzene + Vaseline (11)
Benzoic Acid (1)
Carbon Disulfide (8)
Chloro Acetic Acid (1). (6)
Chloro Benzene (27)(18)
Cyclohexane (16)(17)
Di chloro Acetic Acid (1)
Di methyl Aniline (24)(29)
Di methyl Oxalate (3)
Di methyl Pyrone (2)
Di methyl Succinate (3)
Ethyl Ether (8)
Ethylene Bromide (9)(14)(15)
Formamide (19)
Formic Acid (18)
Mesidine (24)
Mercuric Acetate (7)
Mercuric Acetate + Phenol (7)
α and β Naphthylamine (21)
Nitrobenzene (9) (18)
o, m, p Phenylene diamine (21)
Phenol (7)
Phenyl Hydrazine (32)(29)
Picric Acid (4)
Piperidine (29)
Propyl Alcohol (8)
Pyridine (29)
Phosphorus Acid (26)
Quinoline (29)
Sodium Acetate (5)
Sulfuric Acid (8)
Styryl Ketone (30)
o, m, p Toluidine (21) (24)
Thymol (20)
Trichloro Acetic Acid (1)
Urea (28)(21)
Urethan (28)
p Xylene (20)

(1) Kendall, 1914; (2) Kendall, 1914(a); (3) Kendall and Booge, 1916; (4) Kendall, 1916; (5) Kendall and Adler, 1921; (6) Mameli and Mannessier, 1913; (7) Mameli and Cocconi, 1922; (8) Pickering, 1893; (9) Dahms, 1895; (10) Dahms, 1896; (11) Roloff, 1895; (12) Groschuff, 1911; (13) Baud, 1912; (14) Baud, 1912(a); (15) Baud, 1912(b); (16) Baud, 1913(a); (17) Baud, 1913(b); (18) Baud, 1913(c); (19) English and Turner, 1915; (20) Paterno and Ampola, 1897; (21) Kremann, Weber and Zechner, 1925; (22) Kremann and Zechner, (1925); (23) O'Connor, 1921; (24) O'Connor, 1924; (25) Kremann Mauermann and Oswald, 1922; (26) Redfield and King, 1936; (27) Burnham and Madgin, 1936; (28) Puschin and Rikovsky, 1932; (29) Puschin and Rikovsky, 1932(a); (30) Puschin and König, 1928; (31) Bradley and Marsh, 1933; (32) Trifonov and Tscherbow, 1929.

## GLYCOLIC ACID $CH_2OH.COOH$.

Distribution of Glycolic Acid Between Water and Ether.
(Pinnow, 1919.)

Results at 15°.

| Concentration of acid in $H_2O$ layer (1). | Concentration of acid in $(C_2H_5)_2O$ layer (2). | $\frac{(1)}{(2)}$. |
|---|---|---|
| 0.741 | 0.0235 | 31.5 |
| 0.3695 | 0.0114 | 32.4 |
| 0.179 | 0.0055 | 32.5 |
| 0.120 | 0.00375 | 32.0 |
| 1.258 | 0.0398 | 31.6 |

Results at 25°–8°.

| Concentration of acid in $H_2O$ layer (1). | Concentration of acid in $(C_2H_5)_2O$ layer (2). | $\frac{(1)}{(2)}$. |
|---|---|---|
| 1.0975 | 0.0307 | 35.7 |
| 0.3442 | 0.0090 | 38.2 |
| 0.174 | 0.0048 | 36 3 |
| 0.1125 | 0.0026 | 44.1 |

DISTRIBUTION OF GLYCOLIC ACID AT 20° BETWEEN:
(Dietzel and Schmitt, 1932.)

| Water and Ethyl Ether | | Water and Amyl Alcohol | |
|---|---|---|---|
| Gm. Mols. $CH_2OH.COOH$ per liter | | Gm. Mols. $CH_2OH.COOH$ per liter | |
| $H_2O$ layer | $(C_2H_5)_2O$ layer | $H_2O$ layer | $C_5H_{11}OH$ layer |
| 0.250 | 0.0087 | 0.243 | 0.0415 |
| 0.442 | 0.0141 | 0.429 | 0.0769 |
| 0.634 | 0.0195 | 0.677 | 0.1241 |
| 0.890 | 0.0267 | 0.925 | 0.1713 |
| 1.146 | 0.0339 | 1.173 | 0.2185 |

## THIACETIC ACID $CH_3COSH$.

DISTRIBUTION OF THIACETIC ACID AT 25° BETWEEN : (Smith, 1921, 1922.)

| Water and Ethyl Ether | | | Acetone and Glycerol. | | |
|---|---|---|---|---|---|
| Millimols. $CH_3COSH$ per liter. | | | Millimols. $CH_3COSH$ per liter. | | |
| $H_2O$ layer ($C_1$). | $(C_2H_5)_2O$ layer ($C_2$). | $\frac{C_2}{C_1}$. | Acetone layer (A). | Glycerol layer (G). | $\frac{A}{G}$. |
| 0.967 | 0.802 | 0.830 | 3.04 | 1.56 | 1.95 |
| 1.39 | 1.165 | 0.839 | 5.36 | 2.36 | 2.27 |
| 3.175 | 2.675 | 0.843 | 9.40 | 3.60 | 2.62 |
| 6.00 | 5.30 | 0.884 | 14.30 | 4.60 | 3.10 |
| 9.70 | 8.50 | 0.877 | 30.10 | 9.40 | 3.20 |

## ETHYL BROMIDE (Bromo Ethane) $CH_3CH_2Br$.

SOLUBILITY OF ETHYL BROMIDE IN WATER.

| t° | Gms. $C_2H_5Br$ per 100 gms. $H_2O$ | Authority |
|---|---|---|
| 0 | 1.067 | Rex, 1906 |
| 10 | 0.965 | " " |
| 17.5 | 0.963 | Führer, 1924 |
| 20 | 0.914 | Rex, 1906 |
| 30 | 0.896 | " " |
| 30 | 0.893 | Van Arkel and Vles, 1936 |

SOLUBILITY OF ETHYL BROMIDE IN ETHYL ETHER.
(Parmentier, 1892.)

| t° | Gms. $C_2H_5Br$ per 100 gms. $(C_2H_5)_2O$ | t° | Gms. $C_2H_5Br$ per 100 gms. $(C_2H_5)_2O$ |
|---|---|---|---|
| -13 | 632 | 22.5 | 302 |
| 0 | 561 | 32 | 253 |
| 12 | 462 | | |

Freezing-point data are given for:

Ethyl Bromide + Carbon disulfide (Timmermans, 1934.)
" " + Benzene (Wyatt, 1929.)
" " + n Butyl bromide (Timmermans, 1934.)
" " + iso Butyl bromide " "
" " + Ethylene bromide (Timmermans, 1928; (a).)
" " + Methylene bromide (Timmermans, 1934.)
" " + iso Pentane (Sapgir, 1929.)
" " + Propyl bromide " "

(a) Timmermans and Mme. Vesselovsky, 1931.

## ETHYL CHLORIDE (Chloro Ethane) $CH_3CH_2Cl$.

### Solubility of Ethyl Chloride in Water.

| $t^0$ | Gms. $C_2H_5Cl$ per 100 gms. $H_2O$ | Authority |
|---|---|---|
| 0 | 0.447 | Van Arkel and Vles, 1936 |
| 17.5 | 0.57 | Führer, 1924 |

### Solubility of Ethyl Chloride in Carbon Tetrachloride and in Dichloro Ethane.

(Kaplan and Romantchouk, 1936.)

| Solvent | $t^0$ | cc $C_2H_5Cl$ (at $0^0$ and 760mm) dissolved per 1cc solvent at: 100 | 150 | 200 | 240 | 300 | 500 | 640mm Hg pressure |
|---|---|---|---|---|---|---|---|---|
| $CCl_4$ | -10 | 16 | 30 | 58 | 148 | — | — | — |
| " | 0 | 10 | 16 | 40 | 58 | 114 | — | — |
| " | +20 | 10 | 16 | 22 | 30 | 40 | 118 | 300 |
| $C_2H_4Cl_2$ | -10 | 50 | 112 | 190 | 300 | — | — | — |
| " | 0 | 37 | 70 | 107 | 150 | 227 | — | — |
| " | +20 | 25 | 38 | 52 | 67 | 85 | 182 | 340 |

### Solubility of Ethyl Chloride in Organic Solvents at $32^0$.

(Zellhoeffer, 1937; Zellhoeffer, Copley and Marvel, 1938.)

| Solvent | Formula Formula | Gms. $C_2H_5Cl$ per 100 cc. Solvent at 557 mm pressure(1) |
|---|---|---|
| Carbitol acetate | $C_2H_5O(CH_2CH_2O)_2COCH_3$ | 23.8 |
| Carbitol ethyl ether | $C_2H_5O(CH_2CH_2O)_2C_2H_5$ | 27.8 |
| Dimethyl ether of tetraethylene glycol | $CH_3O(CH_2CH_2O)_4CH_3$ | 21.8 |
| " " " | " | 23.7 (2) |
| Diethyl ether of tetraethylene glycol | $C_2H_5O(CH_2CH_2O)_4C_2H_5$ | 21.2 |
| Dimethyl ether of triethylene glycol | $[CH_3O(CH_2)_2OCH_2]_2$ | 17.0 |
| Butyl carbitol acetate | $\underline{n}\ C_4H_9O(CH_2CH_2O)_2COCH_3$ | 22.5 |
| Diethylene glycol diacetate | $[CH_3COOCH_2CH_2]_2O$ | 18.1 |
| 1.1.2.2 Tetrachloro ethane | $Cl_2CHCHCl_2$ | 30.8 |
| Ethyl ether of diethylene glycol acetate | $C_2H_5O(CH_2CH_2O)_2COCH_3$ | 24.5 (2) |
| Diethyl ether of diethylene glycol | $C_2H_5O(CH_2CH_2O)_2C_2H_5$ | 30.6 (2) |

(1) Vapor pressure of $C_2H_5Cl$ at $4.5^0$.
(2) Gms. per 100 gms. solvent at 557 mm pressure and $32.2^0$.

## GLYCOL CHLOR HYDRINE $CH_2ClCH_2OH$.

Results for the critical solution temperature of mixtures of glycol chlor hydrine and $\underline{i}$ Octane are given by Cornish, Archibald, Murphy and Evans, 1934.

## ETHYL IODIDE (Iodo Ethane) $CH_3CH_2I$.

### Solubility of Ethyl Iodide in Water.

| t° | Gms. $C_2H_5I$ per 100 gms. $H_2O$ | Authority |
|---|---|---|
| 0 | 0.441 | Rex, 1906 |
| 10 | 0.414 | " |
| 20 | 0.403 | " |
| 22.5 | 0.390 | Führer, 1924 |
| 30 | 0.404 | Gross and Saylor, 1931 |
| 30 | 0.415 | Rex, 1906 |

The distribution coefficient, defined as the milligrams of $C_2H_5I$ per liter of blood divided by the mgs. per liter of the saturaging gas mixture, composed of approximately 40 mgs. $C_2H_5I$ per liter of air, was found to be 6.7 at 37°, for the bloods of 15 normal individuals. A correlation of this value and the number of red blood cells and the percentage of haemoglobin was made.

Freezing-point data for mixtures of Ethyl Iodide and Ethyl Ether are given by Wroczynski and Guye, 1910.

## ETHYL HYPOCHLORITE $C_2H_5OCl$

### Distribution of Ethyl Hypochlorite Between Water and Carbon Tetrachloride.

(Taylor, Mac Mullin and Gammal, 1925.)

Carbon tetrachloride containing ethyl hypochlorite was stirred with an equal volume of water untill equilibrium was reached, and samples of each layer were withdrawn and analyzed for available chlorine.

| t°. | Mols. $C_2H_5OCl$ per liter of $CCl_4$. | Mols. $C_2H_5OCl$ per liter of $H_2O$. | t°. | Mols. $C_2H_5OCl$ per liter of $CCl_4$. | Mols. $C_2H_5OCl$ per liter of $H_2O$. |
|---|---|---|---|---|---|
| 5..... | 0.3355 | 0.0805 | 22.5..... | 0.0637 | 0.0321 |
| »..... | 0.1583 | 0.0541 | 36.0..... | 0.3121 | 0.0759 |
| »..... | 0.0690 | 0.0341 | » ..... | 0.1642 | 0.0540 |
| 22.5..... | 0.3499 | 0.08019 | » ..... | 0.0692 | 0.0344 |
| » ..... | 0.1997 | 0.0597 | | | |

## ACETAMIDE $CH_3CO.NH_2$.

### Solubility in Water and in Alcohol. (Speyers, 1902)

| t°. | In Water. (a). | (b). | (c). | In Ethyl Alcohol. (a). | (b). | (c). |
|---|---|---|---|---|---|---|
| 0..... | 105.5 | 138.0 | 29.6 | 85.62 | 29.0 | 18.5 |
| 10..... | 104.9 | 170.0 | 34.0 | 86.2 | 43.0 | 26.0 |
| 20..... | 104.3 | 220.0 | 40.8 | 87.3 | 65.0 | 33.8 |
| 30..... | 103.7 | 300.0 | 47.7 | 88.8 | 100.0 | 43.0 |
| 40..... | 103.0 | 410.0 | 55.5 | 90,7 | 145.0 | 53.5 |
| 50..... | 102.3 | 560.0 | 64.0 | 93.0 | 220.0 | 64.5 |
| 60..... | 101.6 | 850.0 | 74.0 | 95.5 | 370.0 | 76.5 |

(a) Wt. of 100 cc. sat. solution in gms. (b) Gms. Acetamide per 100 gms. solvent. (c) Gm. mols. Acetamide per 100 gm. mols. solution.

100 gms. commercial absolute ethyl alcohol dissolve 31.5 gms. Acetamide at 20-25° C. (Pucher and Dehn, 1921.)

Results for the freezing-point depressions of aqueous acetamide solutions containing increasing gram formular weights of $CH_3CONH_2$ per 1000 gms. of $H_2O$ are given by Chadwell and Poleti, 1938.

$C_2H_5O_1$

## Solubility of Acetamide in Benzene by the Synthetic Method.

(Moles and Jimeno, 1913.)

| t° | Gms. Acetamide per 100 gms. Acetamide layer. | Gms. Acetamide per 100 gms. Benzene layer. | t° | Gms. Acetamide per 100 gms. Acetamide layer. | Gms. Acetamide per 100 gms. Benzene layer. |
|---|---|---|---|---|---|
| 100..... | 86.0 | 4.0 | 135 ..... | 59.0 | 11.5 |
| 110..... | 81.0 | 5.0 | 137.5..... | 55.0 | 14.0 |
| 120..... | 74.0 | 6.5 | 140..... | 50.0 | 19.0 |
| 125..... | 70.0 | 7.0 | 142..... | 39.0 | 24.0 |
| 130..... | 65.0 | 8.5 | 142.5 crit. t.. | 34.0 | |

## Solubility of Acetamide in Urethan and in *p* Toluidine.

(Mortimer, 1923.)

| | In Urethan. | | | In *p* Toluidine | |
|---|---|---|---|---|---|
| t°. | Gms. acetamide per 100 gms. Urethan. | Mols. per cent Acetamide. | t°. | Gms. acetamide per 100 gms. *p* Toluidine. | Mols. per cent Acetamide. |
| 40... | 65.7 | 49.8 | 40... | 27.2 | 33.0 |
| 60... | 179.2 | 73.0 | 60... | 35.5 | 60.8 |
| 70... | 295.8 | 87.1 | 70... | 213.8 | 79.5 |

100 gms. pyridine dissolve 17.75 gms. acetamide at 20–25°; 100 gms. aq. 50 per cent pyridine dissolve 84.7 gms. acetamide at 20–25°. (Dehn, 1917.)

## Critical Solution Temperatures of Separation of Mixtures of Acetamide and Other Compounds.

(Lecat, 1927a; 1928, 1929, 1930.)

| Mixture of $CH_3CONH_2$ and: | t° of Separation | Percent $CH_3CONH_2$ in Mixture | Mixture of $CH_3CONH_2$ and: | t° of Separation | Percent $CH_3CONH_2$ in Mixture |
|---|---|---|---|---|---|
| Acenaphthene | 178 | 64 | Ethyl oxalate | 31.5 | — |
| i Amyl Benzoate | 140 | 55 | Ethyl benzoate | 70.8 | — |
| i Amyl butyrate | 126.8 | 12 | Eugenol | 59.5 | — |
| i Amyl valerate | 163 | 16 | Eugenol methyl ether | 61.5 | — |
| i Amyl oxalate | 113 | — | i " " " | 74 | — |
| Benzyl acetate | 56 | — | Guaicol | 20.5 | — |
| Borneol | 116 | — | Geraniol | 58.6 | — |
| Bornyl acetate | 134 | 32 | Indol (from Indene) | 144 | 17.5 |
| Bromo benzene | 110 | 4 | p Iodo toluene | 175 | — |
| Bromo α naphthalene | 175 | 56.5 | β Iso safuol | 128.5 | 47 |
| p Bromo toluene | 156 | — | Menthol | 45 | — |
| i Butyl benzoate | 126 | 42.5 | Methyl benzoate | 61.7 | — |
| n " " | 132 | 49 | p Methyl acetophenone | 54.4 | — |
| i " valerate | 119 | 10.5 | Methyl cinnamate | 60.8 | — |
| i " valerianate | 163 | — | Methyl salicylate | 80.6 | 29 |
| Chloro α naphthalene | 168.3 | 52 | Methyl α naphthalene | 169.5 | 44 |
| p chloro nitro benzene | 73.2 | — | Naphthalene | 148.5 | 27 |
| Cineol | 67 | — | o Nitro phenol | 43 | — |
| Citronelal | 50 | — | Penta chloro ethane | 95 | 3 |
| p Cresol methyl ether | 107 | 11 | Phenetol | 108.5 | 11 |
| Di benzyl | 185 | 68 | Phenyl acetate | 30 | — |
| p Di bromo benzene | 180 | 18 | Phenyl ether | 113 | — |
| o Di chloro benzene | 150 | 11 | Phenyl oxide | 160.8 | 52 |
| p " " | 148.5 | 10 | Pulegon | 66 | 36 |
| Di methyl aniline | 120.5 | 17.3 | Propyl benzoate | 115 | — |
| o Di methyl toluidine | 174 | 16.5 | Saf rol | 136.5 | 32 |
| Di phenyl | 167 | 50.5 | i " | 128.5 | — |
| " methane | 178 | 56.5 | o Toliudine | 24.3 | — |
| Di ethyl aniline | 179 | 25 | m Xylene | 79 | 10 |
| Ethyl salicylate | 103.5 | 40 | | | |

## ACETAMIDE

Freezing-point data are given for mixtures of Acetamide and each of the following compounds:

| | | |
|---|---|---|
| Acetic acid (1) | o, m & p Dioxy benzene (2) | Phenol (4)(10) |
| Acetic anhydride (1) | α & β Naphthol (2) | Phenol + $C_2H_5OH$ (4) |
| Benzene (7) | o, m & p Nitrophenol (2) | Pyrogallol (5) |
| Benzoic Acid (1) | Nitroso dimethyl aniline(3) | Salicylic acid (6) |
| Benzoic anhydride (1) | Oxy benzoic acid (2) | Triphenyl guanidine (8) |
| Camphor (9) | Phthalide (8) | |

(1) Kremann, Mauerman and Oswald, 1922 (2) Kremann and Auer, 1918; (3) Kremann and Wlk, 1919; (4) Kremann and Wenznig, 1917; (5) Kremann and Zechner, 1918; (6) Rheinboldt, Henning and Kircheisen, 1925; (7) Moles and Jimeno, 1913; (8) Lautz, 1913; (9) Jefremow, 1915; (10) Boon, 1939.

## METHYL URETHAN $NH_2COOCH_3$.

### Distribution of Methyl Urethan Between Water and Olive Oil.

(Baum, 1899; H. von Meyer, 1909.)

| $t^o$ | Gms. $NH_2COOCH_3$ per 100 cc | | $\frac{C_2}{C_1}$ |
|---|---|---|---|
| | $H_2O$ layer ($C_1$) | Oil layer ($C_2$) | |
| room temp. | 7.50 | 0.275 | 0.037 |

Freezing-point data for mixtures of Methyl Urethan and Menthol are given by Scheuer, 1910

## GLYCINE (Glycocoll) $CH_2NH_2COOH$.

### Solubility of Glycine in Water.

(Dalton and Schmidt, 1933.)

The following values are those derived from a solubility equation based upon the results of thirty very careful solubility determinations made at ten temperatures between 0° and 60°. Previous determinations by Dehn, 1917,; Pfeiffer and Wüngler, 1916; Pfeiffer and Angern, 1924; Cohn, 1932, Sano, 1926a and Ando, 1926, differ more or less from the present results. The authors also give density determinations at 25° of aqueous glycine solutions varying in concentration from 9.2 to 20.4 per-cent $CH_2NH_2COOH$. The following results shown in parentheses are by Dunn, Ross and Reed, 1933. The density of the saturated solution at 25° is given as 1.0831 by McMeekin, Cohn and Weare, 1936.

| $t^o$ | Gms. $CH_2NH_2COOH$ per 100 gms. $H_2O$ | $t^o$ | Gms. $CH_2NH_2COOH$ per 100 gms. $H_2O$ | $t^o$ | Gms. $CH_2NH_2COOH$ per 100 gms. $H_2O$ |
|---|---|---|---|---|---|
| 0 | 14.18 (14.31) | 30 | 27.59 | 60 | 45.26 |
| 5 | 16.03 | 35 | 30.32 | 65 | 48.35 |
| 10 | 18.04 | 40 | 33.16 | 70 | 51.39 |
| 15 | 20.20 | 45 | 36.19 | 75 | 54.39 (57.49) |
| 20 | 22.52 | 50 | 39.10 (40.15) | 100 | 67.17 (75.20) |
| 25 | 24.99 (25.31) | 55 | 42.18 | | |

## GLYCINE

### Solubility of Glycine in Water and in Aqueous Solutions of Salts at 20°.

(Pfeiffer and Würgler, 1916.)

Solutions of the neutral salts of known content were shaken with glycine two days at 20°. This period was sufficient for complete saturation. The glycine present in the saturated solution was determined by the Sörensen titration method. Tests showed that the salts present did not interfere with the accuracy of the method. For the solutions in which large quantities of glycine dissolved, a correction of the concentration of the salt resulting from the expansion of the solution, was applied. This was 0.58 cc. for each gram of glycol in 2 cc. of the sat. solution made with salt solution containing $m$ mols of salt per 10 cc. The correction formula is $x = m\left(\frac{2 - n \cdot 0.58}{2}\right)$ in which $n$ is the grams of glycol per 2 cc.

| Salt used | Mols. salt per liter of original solution. | Mols. salt per liter of final sol. sat. with glycine. | Gms. Glycine per 100 cc. sat. sol. |
|---|---|---|---|
| LiCl.... | 0.96 | 0.843 | 20.94 |
| LiBr.... | 0.97 | 0.851 | 21.22 |
| NaCl... | 1.00 | 0.881 | 20.49 |
| " ... | 2.00 | 1.76 | 20.90 |
| " ... | 4.00 | 3.50 | 21.28 |
| NaBr.. | 1.00 | 0.88 | 20.62 |
| NaI.... | 0.96 | 0.844 | 20.90 |
| $NaNO_3$.. | 0.5 | 0.44 | 20.75 |
| " .. | 1.0 | 0.874 | 21.76 |
| " .. | 2.0 | 1.73 | 23.12 |
| " .. | 4.0 | 3.42 | 24.89 |
| $NaClO_3$ | 1.0 | 0.870 | 21.74 |
| $Na_2SO_4$ | 0.5 | 0.439 | 20.95 |
| KCl.... | 0.5 | 0.443 | 19.78 |
| " .... | 1.0 | 0.886 | 19.78 |
| " .... | 2.0 | 1.77 | 19.60 |
| " .... | 4.0 | 3.59 | 17.81 |
| $CaBr_2$.. | 0.5 | 0.436 | 24.97 |
| $CaCl_2$..... | 0.267 | 0.234 | 21.48 |
| " ..... | 0.534 | 0.461 | 23.48 |
| " ... | 0.57 | 0.49 | 24.24 |
| " ..... | 1.07 | 0.90 | 27.35 |
| " ..... | 2.14 | 1.70 | 35.08 |
| $Ca(NO_3)_2$.. | 0.5 | 0.426 | 25.57 |
| $Ba(ClO_4)_2$.. | 0.412 | 0.351 | 25.45 |
| " .. | 0.617 | 0.520 | 27.66 |
| " .. | 0.836 | 0.693 | 29.49 |
| $BaCl_2$..... | 0.5 | 0.431 | 23.75 |
| $BaBr_2$.... | 0.5 | 0.428 | 24.54 |
| $Ba(NO_3)_2$.. | 0.5 | 0.428 | 24.85 |
| $SrCl_2$..... | 0.25 | 0.219 | 21.36 |
| " ..... | 0.5 | 0.432 | 23.31 |
| " ..... | 1.0 | 0.849 | 26.05 |
| " ..... | 2.0 | 1.62 | 33.01 |
| $SrBr_2$.... | 0.49 | 0.424 | 24.40 |
| $Sr(NO_3)_2$.. | 0.5 | 0.428 | 24.91 |

Several determinations in 2.0 normal solutions of LiBr, NaBr and KBr made with 2.0 normal HCl instead of water gave 34.7 gms. glycine per 100 cc. in each case. A similar determination made with 2.0 $n$ $NaNO_3$ in 2.0 $n$ HCl gave 37.56 gms. glycine.

100 cc aqueous solution simultaneously saturated with potassium chloride and glycine at 20° contain 18.0 gms. $CH_2NH_2COOH$ + 27.0 gms. KCl. (Pfeiffer and Modelski, 1912.)

10 cc of saturated cold aqueous magnesium perchlorate solution dissolve about 8.0 gms. of $NH_2CH_2COOH$. (Du claux and Durand-Gasselin, 1938.)

### Solubility of Glycine in Aqueous Salt Solutions at 22°.

(Ando, 1931.)

| Aqueous Solution of: | Conc. of Aq. Sol. | Gms. $NH_2CH_2COOH$ per liter sat. sol. | Aqueous Solution of: | Conc. of Aq. Sol. | Gms. $NH_2CH_2COOH$ per liter sat. sol. |
|---|---|---|---|---|---|
| RbCl | 1.0 n | 195.1 | $K_2SO_4$ | 1.0 n | 208.5 |
| KCl | 1.0 n | 203.9 | KI | 1.0 n | 209.2 |
| " | 3.0 n | 199.2 | $CH_3COONa$ | 1.0 n | 196.1 |
| NaCl | 1.0 n | 209.8 | $BaCl_2$ | 1.0 n | 234.9 |
| " | 3.0 n | 215.4 | $CaCl_2$ | 1.0 n | 242.9 |
| LiCl | 1.0 n | 217.6 | Mannitol | 0.5 n | 186.7 |
| KBr | 1.0 n | 205.1 | Cane Sugar | 1.0 n | 155.7 |
| $KNO_3$ | 1.0 n | 208.5 | " " | 1.0 n | 196.9 |

## Solubility of Glycine in Aqueous Solutions of Ethyl Alcohol.

(Dunn and Ross, 1938.)

| t° | Wt. Percent $C_2H_5OH$ in Solvent | d. of sat. solution | Gms. $CH_2NH_2COOH$ per 100 gms. solvent | t° | Wt. Percent $C_2H_5OH$ in Solvent | d. of sat. solution | Gms. $CH_2NH_2COOH$ per 100 gms. solvent |
|---|---|---|---|---|---|---|---|
| 0 | 20.32 | 0.988 | 3.95 | 45 | 20.32 | 1.01 | 15.0 |
| 0 | 42.52 | 0.942 | 1.03 | 45 | 42.52 | 0.928 | 4.62 |
| 0 | 67.27 | 0.884 | 0.20 | 45 | 66.94 | 0.856 | 0.756 |
| 0 | 92.54 | 0.820 | 0.008 | 45 | 92.61 | 0.795 | 0.0294 |
| 25 | 20.32 | 0.994 | 8.72 | 65 | 20.32 | 1.03 | 24.5 |
| 25 | 42.52 | 0.931 | 2.47 | 65 | 42.52 | 0.930 | 8.03 |
| 25 | 66.94 | 0.869 | 0.448 | 65 | 66.94 | 0.847 | 1.23 |
| 25 | 92.61 | 0.806 | 0.0172 | 65 | 92.61 | 0.784 | 0.0488 |

## Solubility of Glycine in Aqueous Solutions of Ethyl Alcohol at 25°.

(Cohn, McMeekin, Edsall and Weare, 1934.)

| Vol. Percent $C_2H_5OH$ in Solvent | d. of Solvent | d. of sat. Solution | Gms. $CH_2NH_2COOH$ per 100 gms. sat.sol. | Vol. Percent $C_2H_5OH$ in Solvent | d. of Solvent | d. of sat. Solution | Gms. $CH_2NH_2COOH$ per 100 gms. sat. sol. |
|---|---|---|---|---|---|---|---|
| 0.0 | 0.9971 | 1.0831 | 20.00 | 20.0 | 0.9717 | 1.0140 | 9.944 |
| 5.0 | 0.9901 | 1.0646 | 17.31 | 40.0 | 0.9447 | 0.9611 | 3.962 |
| 10.0 | 0.9935 | 1.0464 | 14.64 | 60.0 | 0.9051 | 0.9107 | 1.296 |
| 15.0 | 0.9774 | 1.0307 | 12.16 | 80.0 | 0.8550 | 0.8598 | 0.243 |

Data for the solubility of glycine in aqueous and in aqueous alcohol solutions of different hydrogen ion concentrations are given by Sano, 1926a.

## Solubility of Glycine at 25° in 80 Volume Percent Ethyl Alcohol Containing Increasing Amounts of Sodium Chloride.

(Cohn, McMeekin, Greenstein and Weare, 1936.)

| Gms. NaCl per liter of solvent | d. of solvent | d. of sat. solution | Gms. $CH_2NH_2COOH$ per liter sat. sol. |
|---|---|---|---|
| 0.0 | 0.8550 | 0.8598 | 2.09 |
| 0.05 | 0.8569 | 0.8580 | 2.34 |
| 0.15 | 0.8603 | 0.8617 | 3.00 |
| 0.25 | 0.8646 | 0.8654 | 3.73 |

Similar results are given for Hydantoic Acid, and α Amino-caproic Hydantoic Acid, and in terms of gm. mols. per liter, for a number of Glycine Peptides and Hydantoic Acids.

### Distribution of Glycine Between Water and Butyl Alcohol at 25°.

(England and Cohn, 1935.)

| Gm. Mols. $CH_2NH_2COOH$ per liter of: | | $\frac{C_2}{C_1}$ | Gm. Mols. $CH_2NH_2COOH$ per liter of: | | $\frac{C_2}{C_1}$ |
|---|---|---|---|---|---|
| $H_2O$ layer($C_1$) | Alcohol layer($C_2$) | | $H_2O$ layer($C_1$) | Alcohol layer($C_2$) | |
| 0.208 | 0.0029 | 0.0142 | 1.760 | 0.0113 | 0.0065 |
| 0.701 | 0.0083 | 0.0119 | 2.443 | 0.0129 | 0.0053(1) |
| 1.353 | 0.0108 | 0.0081 | | | |

(1) In this case solid $CH_2NH_2COOH$ was present and these results correspond respectively to the solubility of glycine in water saturated with butyl alcohol and to the solubility in butyl alcohol saturated with water.

The solubility of butyl alcohol in water saturated with glycine at 25° was found to be 0.44 gm. mols. per liter.

### Solubility of Glycine in Several Solvents at 25°.

( (McMeekin, Cohn and Weare, 1936.)

| Solvent | Formula | d. of sat. solution | Gm. Mols. $CH_2NH_2COOH$ per liter sat. sol. |
|---|---|---|---|
| Water | $H_2O$ | 1.0831 | 2.886 |
| Formamide | $HCONH_2$ | 1.13306 | 0.0838 |
| Methanol | $CH_3OH$ | 0.78696 | 0.00426 |
| Ethanol | $C_2H_5OH$ | 0.7851 | 0.00039 |
| Butanol | $CH_3(CH_2)_2CH_2OH$ | 0.80674 | 0.0000959 |
| Acetone | $CH_3COCH_3$ | 0.78566 | 0.0000305 |

### Solubility of Glycine in Several Solvents.

(Dehn, 1917; Pucher and Dehn, 1921.)

| Solvent | t° | Gms. $CH_2NH_2COOH$ per 100 gms. solvent |
|---|---|---|
| Pyridine | 20-25 | 0.61 |
| Aq. 50% Pyridine | " | 0.74 |
| Quinoline | " | 0.07 |
| Ethyl Alcohol | " | 0.06 |
| Equiv. mol. mixture of Quinoline and Ethyl Alcohol | " | 0.17 |

**BIURET** (Carbamyl urea) $NHCONH_2CONH_2.H_2O$.

Freezing-point data for mixtures of Buiret and Urea are given by Janecke and Rahlfs, 1932.

**PhosphonoACETIC ACID** $HOOC.CH_2PO(OH)_2$.

100 gms. saturated solution in Water contain 64.5 gms. $HOOC.CH_2PO(OH)_2$ at 0°.

(Nylén, 1926.)

**ETHANE** $C_2H_6$.

SOLUBILITY IN WATER.
(Winkler, 1901.)

| t°. | β. | β′. | q. | t°. | β. | β′. | q. |
|---|---|---|---|---|---|---|---|
| 0 | 0.0987 | 0.0982 | 0.0132 | 40 | 0.0292 | 0.0271 | 0.0037 |
| 5 | 0.0803 | 0.0796 | 0.0107 | 50 | 0.0246 | 0.0216 | 0.0029 |
| 10 | 0.0656 | 0.0648 | 0.0087 | 60 | 0.0218 | 0.0175 | 0.0024 |
| 15 | 0.0550 | 0.0541 | 0.0073 | 70 | 0.0195 | 0.0135 | 0.0018 |
| 20 | 0.0472 | 0.0462 | 0.0062 | 80 | 0.0183 | 0.0097 | 0.0013 |
| 25 | 0.0410 | 0.0398 | 0.0054 | 90 | 0.0176 | 0.0054 | 0.0007 |
| 30 | 0.0362 | 0.0347 | 0.0049 | 100 | 0.0172 | 0.0000 | 0.0000 |

$\beta$ = Absorption coefficient, *i.e.*, the volume of gas (reduced to 0° and 760 mm.) absorbed by 1 volume of the liquid when the pressure of the gas itself without the tension of the liquid amounts to 760 mm.

$\beta'$ = Solubility, *i.e.*, the volume of gas (reduced to 0° and 760 mm.) which is absorbed by one volume of the liquid when the barometer indicates 760 mm. pressure.

$q$ = the weight of gas in grams which is taken up by 100 grams of the pure solvent at the indicated temperature and a total pressure (that is, the partial pressure of the gas plus the vapor pressure of the liquid at the absorption temperature) of 760 mm.

Freezing-point data for mixtures of ethane and hydrochloric acid are given by Baume and Georgitses, 1912, 1914.

SOLUBILITY OF ETHANE IN SEVERAL ALCOHOLS AND OTHER SOLVENTS.
(McDaniel, 1911.)

| Solvent | t° | Abs. Coef. A | Bunsen Coef. B. |
|---|---|---|---|
| Methyl alcohol(99%) | 22.5 | 2.0235 | 1.8710 |
| " " | 30.1 | 1.8817 | 1.6952 |
| " " | 42.5 | 1.7304 | 1.4852 |
| Ethyl alcohol(99.8%) | 22.0 | 2.3344 | 2.1616 |
| " " | 30.0 | 2.2151 | 1.9951 |
| " " | 40.0 | 2.0657 | 1.8020 |
| Hexane | 22.1 | 3.3508 | 3.1035 |
| " | 30.0 | 3.1842 | 2.8680 |
| " | 55.0 | 2.8812 | 2.4008 |
| Heptane | 30 | 4.4200 | 3.9820 |
| " | 40 | 4.2632 | 3.7182 |
| Ethyl Acetate | 22 | 3.0800 | 2.8521 |
| " " | 30 | 3.0601 | 2.7575 |
| " " | 40 | 3.003 | 2.6178 |
| Amyl Acetate | 22 | 3.5761 | 3.3085 |
| " " | 30 | 3.3891 | 3.0518 |
| " " | 50 | 2.8909 | 2.4433 |

Abs. coef. $A$ = vol. of ethane absorbed by unit volume of solvent at the temp. stated.
For definition of Bunsen Coef. $B$, see $\beta$ above.
Additional data for the solubility of ethane in amyl alcohol are given by (Friedel and Gorgeu, 1908).

ETHANE $C_2H_6$.

SOLUBILITY OF ETHANE IN SEVERAL SOLVENTS AT VARIOUS TEMPERATURES.
(Horiuti, 1931.)

| t° | Solubility of $C_2H_6$ in terms of the Ostwald Solubility Expression $l$ in: | | | | |
|---|---|---|---|---|---|
| | $CCl_4$ | $(CH_3)_2CO$ | $CH_3COOCH_3$ | $C_6H_6$ | $C_6H_5Cl$ |
| 0 | 7.648 | 4.202 | 4.195 | — | 4.900 |
| 10 | 6.604 | 3.761 | 3.780 | 4.885 | 4.270 |
| 20 | 5.716 | 3.389 | 3.414 | 4.360 | 3.750 |
| 25 | 5.366 | 3.225 | 3.246 | 4.120 | 3.534 |
| 30 | 5.016 | 3.067 | 3.106 | 3.921 | 3.340 |
| 40 | 4.446 | 2.790 | 2.825 | 3.552 | 3.013 |
| 50 | — | — | — | 3.255 | 2.745 |
| 60 | — | — | — | — | 2.509 |
| 70 | — | — | — | — | 2.312 |
| 80 | — | — | — | — | 2.146 |

The Ostwald Solubility Expression $l$ is the ratio of the volume (v) of the gas absorbed at any pressure and temperature, to the volume (V) of the absorbing liquid, that is $l = \frac{v}{V}$.

One liter of Cyclohexanol dissolve 711.5 cc $C_2H_6$ at 26° and 766 m pressure. Cauquil, 1927.

Results for the pressure-temperature diagrams of the following systems are given by Scheffer and Smittenberg, 1933.

$C_2H_6$ + p dichloro benzene
" + $\bar{p}$ chloro bromo benzene
" + $\bar{p}$ chloro iodo benzene
" + $\bar{1}$.3.5 tri chloro benzene
" + p chloro aniline

$C_2H_6$ + o chloro nitro benzene
" + m " " "
" + o nitro phenol
" + as o Xylidene
" + p toluidine

## METHYL ETHER $(CH_3)_2O$.

### Solubility of Methyl Ether in Several Solvents at 25° and at Various Pressures.

(Horiuti, 1931.)

Results for solubility in:

| $CCl_4$ | | $(CH_3)_2CO$ | | $CH_3COOCH_3$ | |
|---|---|---|---|---|---|
| Pressure mm | Mol. fraction $(CH_3)_2O$ in sat. sol. | Pressure mm | Mol. fraction $(CH_3)_2O$ in sat. sol. | Pressure mm | Mol. fraction $(CH_3)_2O$ in sat. sol. |
| 112.4 | 0.000 | 229.2 | 0.000 | 213.4 | 0.000 |
| 237.6 | 0.030 | 311.7 | 0.0179 | 293.2 | 0.0175 |
| 360.1 | 0.0596 | 403.1 | 0.0378 | 440.6 | 0.0508 |
| 464.8 | 0.0852 | 548.2 | 0.0701 | 576.0 | 0.0817 |
| 612.8 | 0.1217 | 650.8 | 0.0933 | 704.4 | 0.1117 |
| 782.4 | 0.1633 | 762.3 | 0.1183 | 812.3 | 0.1365 |
| 932.7 | 0.1993 | 939.1 | 0.1577 | 923.5 | 0.1627 |
| 1072.9 | 0.2330 | 1075.0 | 0.1893 | 1039.7 | 0.1950 |

| $C_6H_6$ | | $C_6H_5Cl$ | |
|---|---|---|---|
| Pressure mm | Mol. fraction $(CH_3)_2O$ in sat. sol. | Pressure mm | Mol. fraction $(CH_3)_2O$ in sat. sol. |
| 93.7 | 0.000 | 11.6 | 0.000 |
| 196.9 | 0.0230 | 120.4 | 0.0621 |
| 372.6 | 0.0632 | 310.5 | 0.0720 |
| 503.0 | 0.0932 | 423.3 | 0.0974 |
| 634.8 | 0.1229 | 550.8 | 0.1278 |
| 761.4 | 0.1529 | 795.3 | 0.1855 |
| 913.0 | 0.1884 | 957.9 | 0.2214 |
| 1006.7 | 0.2100 | 1072.1 | 0.2471 |

Freezing-point data are given for:

$(CH_3)_2O$ + $H_2O$ (Baume and Perrot, 1914.)
" + $CHCl_3$ (Baume, 1909, 1914.)
" + $C_2H_2$ (Baume, 1914.)
" + $C_2H_4$ (Baume, 1914.)
" + $CH_3Cl$ (Baume, 1914.)
$(CH_3)_2O$ + $CO_2$ (Baume & Borowski, 1914)
" + NO (Baume and Germann, 1914.)
" + $SO_2$ (Baume, 1914.)

## ETHYL ALCOHOL $C_2H_5OH$.

### Reciprocal Solubility of Ethyl Alcohol and Water at Low Temperatures, Determined by the Freezing-point Method.

(Pictet and Altschul, 1895; Pickering, 1893.)

| t°. of Freezing. | Sp. Gr. Sat. Sol. | Gms. $C_2H_5OH$ per 100 Gms. Sat. Sol. | Solid Phase. | t°. of Freezing. | Sp. Gr. Sat. Sol. | Gms. $C_2H_5OH$ per 100 Gms. Sat. Sol. | Solid Phase. |
|---|---|---|---|---|---|---|---|
| — 1 | 0.9962 | 2.5 | Ice | — 23.6 | 0.9512 | 33.8 | Ice |
| — 2 | 0.9916 | 4.8 | " | — 28.7 | 0.9417 | 39 | " |
| — 3 | 0.9870 | 6.8 | " | — 33.9 | 0.9270 | 46.3 | " |
| — 5 | 0.9824 | 11.3 | " | — 41 | 0.9047 | 56.1 | " |
| — 6.1 | 0.9793 | 13.8 | " | — 50 | ... | 68 | " |
| — 8.7 | 0.9747 | 17.5 | " | — 60 | ... | 75 | " |
| — 9.4 | 0.9732 | 18.8 | " | — 70 | ... | 80 | " |
| —10.6 | 0.9712 | 20.3 | " | — 80 | ... | 83.5 | " |
| —12.2 | 0.9689 | 22.1 | " | —100 | ... | 89.5 | " |
| —14 | 0.9662 | 24.2 | " | —118 Eutec. | ... | 93.5 | " + $C_2H_5OH$ |
| —16 | 0.9627 | 26.7 | " | —115 | ... | 96 | $C_2H_5OH$ |
| —18.9 | 0.9578 | 29.9 | " | —110.5 | ... | 100 | " |

The result for the eutectic and for the f.-pt. of $C_2H_5OH$ are by Puschin and Glagoleva, 1914, 1915; the other data for concentrations of $C_2H_5OH$ above 70% were obtained by exterpolation. Additional data for the freezing-point lowering are given by Rozsa (1911).

Later determinations of the freezing-points of Ethyl Alcohol Water Mixtures by Tarassenkow, 1928, and Laland, 1934, gave an average curve from which the following values were taken.

| t° of freezing | Gms. $C_2H_5OH$ per 100 gms. sat. sol. | Solid Phase | t° of freezing | Gms. $C_2H_5OH$ per 100 gms. sat. sol. | Solid Phase |
|---|---|---|---|---|---|
| - 2.0 | 5.0 | Ice | -38.0 | 50 | Ice |
| - 4.5 | 10. | " | -43.5 | 60 | " |
| - 7.2 | 15 | " | -50.5 | 70 | " |
| -11.0 | 20 | " | -67.0 | 80 | " |
| -15.8 | 25 | " | -87.5 | 85 | " |
| -20.5 | 30 | " | -113.0 | 90 | " |
| -30.5 | 40 | " | -125 Eutec. | 92.5 | " + $C_2H_5OH$ |
| | | | -120 | 95 | $C_2H_5OH$ |
| | | | -114.5 | 100 | " |

Laland also gives density determinations of $C_2H_5OH + H_2O$ mixtures.

### Liquid-Vapor Equilibrium in Ethyl Alcohol-Water Mixtures.

(Wiley and Harden, 1935.)

The apparatus permitted withdrawing samples of the liquid and of the vapor in a cooled recepticle. The samples of liquid and of condensed vapor thus withdrawn were analyzed by means of specific gravity determinations.

| Density 25°/25° of: Liquid | Density 25°/25° of: Vapor | Mol. Percent $C_2H_5OH$ in: Liquid | Mol. Percent $C_2H_5OH$ in: Vapor | Density 25°/25° of: Liquid | Density 25°/25° of: Vapor | Mol. Percent $C_2H_5OH$ in: Liquid | Mol. Percent $C_2H_5OH$ in: Vapor |
|---|---|---|---|---|---|---|---|
| 0.9890 | 0.9320 | 2.5 | 25.0 | 0.8879 | 0.8437 | 37.7 | 59.5 |
| 0.9811 | 0.8867 | 4.8 | 35.7 | 0.8839 | 0.8442 | 39.3 | 59.0 |
| 0.9777 | 0.8820 | 6.0 | 40.0 | 0.8629 | 0.8365 | 49.3 | 64.0 |
| 0.9635 | 0.8693 | 11.0 | 46.0 | 0.8348 | 0.8230 | 65.3 | 73.5 |
| 0.9301 | 0.8547 | 22.7 | 53.5 | 0.8320 | 0.8231 | 66.5 | 72.8 |
| 0.9167 | 0.8516 | 27.0 | 55.0 | 0.8083 | 0.8077 | 81.8 | 82.5 |
| 0.8986 | 0.8480 | 33.4 | 57.0 | | | | |

## ETHYL ALCOHOL $C_2H_5OH$

### The Freezing-Points of Mixtures of Denatured Alcohol and Water.

(Davis and Harvey, 1919).

The denatured alcohol was composed of 100 parts of ethyl alcohol ($d_{20} = 0.811$) 10 parts of methyl alcohol ($d_{20} = 0.817$) and 0.5 part benzolene ($d_{20} = 0.800$, b. pt. 150°-265°). The freezing temperatures were measured by a nickel resistance thermometer. The resistance was read at intervals at a slowly increasing temperature and the break in the curve was taken to indicate the point of change from solid to liquid phase, that is, the melting-point.

| t° of m. pt. | $d_{20}$ of mixture. | Vol. per cent denatured alcohol in mixture. | t° of m. pt. | $d_{20}$ of mixture. | Vol. per cent denatured alcohol in mixture. |
|---|---|---|---|---|---|
| — 2.8... | 0.9935 | 5.0 | —35.7... | 0.9264 | 55.0 |
| — 4.0... | 0.9873 | 10.0 | —38.9... | 0.9138 | 60.0 |
| — 6.0... | 0.9816 | 15.0 | —41.0... | 0.9037 | 65.0 |
| — 8.5... | 0.9753 | 20.0 | —43.6... | 0.8926 | 70.0 |
| —11.5... | 0.9715 | 25.0 | —48.0... | 0.8802 | 75.0 |
| —14.8... | 0.9656 | 30.0 | —53.7... | 0.8677 | 80 0 |
| —18.3... | 0.9592 | 35.0 | —62.0... | 0.8529 | 85.0 |
| —22.1... | 0.9515 | 40.0 | —73.7... | 0.8413 | 90.0 |
| —26.9... | 0.9442 | 45.0 | — ... | 0.8268 | 95.0 |
| —31.1... | 0.9845 | 50.0 | — ... | 0.8117 | 100.0 |

### Reciprocal Solubility of Ethyl Alcohol, Ethyl Ether and Water at 15°.

(Boutin and Sanfourche, 1919.)

The amount of one constituent necessary to produce clouding or clearing in known mixtures of the other two was determined.

| Gms. per 100 gms. Homogeneous mixture | | | Gms. per 100 gms. Homogeneous mixture | | |
|---|---|---|---|---|---|
| $H_2O$. | $C_2H_5OH$. | $(C_2H_5)_2O$. | $H_2O$. | $C_2H_5OH$. | $(C_2H_5)_2O$. |
| 93.0 | 0.0 | 7.0 | 29.5 | 27.8 | 42.9 |
| 87.6 | 4.9 | 7.4 | 23.0 | 27.0 | 50.0 |
| 82.5 | 9.7 | 7.7 | 18.0 | 24.9 | 57.1 |
| 77.1 | 14.9 | 8.0 | 10.7 | 19.4 | 69.9 |
| 69.7 | 20.3 | 10.0 | 6.8 | 14.7 | 78.5 |
| 61.3 | 23.9 | 13.8 | 4.4 | 9.9 | 85.7 |
| 55.7 | 26.1 | 18.3 | 2.5 | 5.0 | 92.4 |
| 49.1 | 27.4 | 23.5 | 1.1 | 0.0 | 98.9 |
| 39.9 | 28.2 | 35.9 | | | |

### Reciprocal Solubility of Ethyl Alcohol, Ethyl Ether and Water at 15°.

(Desvergnes, 1921.)

The volume of ether of $d_{15} = 0.724$, necessary to produce clouding in mixtures of alcohol of $d_{15} = 0.812$ and water, at 15° was determined.

| Aq. — $C_2H_5OH$ Mixture | | cc. Ether to produce clouding. | Sum of Volumes employed. | Actual Volume of Mixture. | Volume of upper layer in mixture of 100 cc. of cloudy liquid + 30 cc. of ether. |
|---|---|---|---|---|---|
| cc. $H_2O$. | cc. $C_2H_5OH$. | | | | |
| 100 | 110 | 159.0 | 369.0 | 356.0 | 97.0 |
| 100 | 100 | 131.0 | 331.0 | 321.0 | 90.0 |
| 100 | 90 | 112.0 | 312.0 | 298.0 | 83.0 |
| 100 | 80 | 81.0 | 261.0 | 251.0 | 72.5 |
| 100 | 70 | 59.0 | 229.0 | 221.0 | 61.0 |
| 100 | 60 | 40.0 | 200.6 | 192.0 | 52.0 |
| 100 | 50 | 32.0 | 182.0 | 177.0 | 43.5 |
| 100 | 40 | 22.5 | 162.5 | 156.5 | 39.0 |
| 100 | 30 | 15.0 | 145.0 | 141.0 | 32.0 |
| 100 | 20 | 13.5 | 133.5 | 129.5 | 31.5 |
| 100 | 10 | 12.5 | 122.5 | 119.0 | 30.0 |

DISTRIBUTION OF ETHYL ALCOHOL AT 25° (Bugarszky, 1910) BETWEEN:

| Bromobenzene and Water. Gms. $C_2H_5OH$ per Liter. | | Carbon Tetrachloride and Water. Gms. $C_2H_5OH$ per Liter. | | Carbon Disulfide and Water. Gms. $C_2H_5OH$ per Liter. | |
|---|---|---|---|---|---|
| $C_6H_5Br$ Layer. | $H_2O$ Layer. | $CCl_4$ Layer. | $H_2O$ Layer. | $CS_2$ Layer. | $H_2O$ Layer. |
| 0.72 | 18.5 | 0.45 | 18.7 | 0.27 | 19.1 |
| 1.36 | 36.9 | 0.93 | 36.5 | 1.87 | 37. |
| 2.68 | 68.2 | 2.55 | 68.1 | 10.23 | 69.3 |

MISCIBILITY OF ETHYL ALCOHOL (see Note p. 4 ) AT 0° WITH MIXTURES OF:

Chloroform and Water. (Bonner, 1910.)

| Composition of Homogeneous Mixtures. | | | |
|---|---|---|---|
| Gms. $CHCl_3$. | Gms. $H_2O$. | Gms. $C_2H_5OH$. | Sp. Gr. Sat. Sol. |
| 0.907 | 0.093 | 0.434 | 1.19 |
| 0.90 | 0.10 | 0.45 | 1.18 |
| 0.80 | 0.20 | 0.60 | 1.12 |
| 0.70 | 0.30 | 0.68 | 1.07 |
| 0.593 | 0.407 | 0.726 | 1.04 |
| 0.501 | 0.499 | 0.729 | 1.03 |
| *0.420 | 0.58 | 0.73 | ... |
| 0.404 | 0.596 | 0.733 | 1.01 |
| 0.300 | 0.70 | 0.70 | 0.99 |
| 0.197 | 0.803 | 0.672 | 0.98 |
| 0.100 | 0.90 | 0.61 | 0.98 |
| 0.088 | 0.912 | 0.608 | 0.98 |

Diethylketone and Water. (Bonner, 1910.)

| Composition of Homogeneous Mixtures. | | | |
|---|---|---|---|
| Gms. $C_2H_5.CO.C_2H_5$. | Gms. $H_2O$. | Gms. $C_2H_5OH$. | Sp. Gr. Sat. Sol. |
| 0.938 | 0.062 | 0.136 | 0.85 |
| 0.900 | 0.10 | 0.19 | 0.85 |
| 0.895 | 0.105 | 0.201 | 0.86 |
| 0.800 | 0.20 | 0.31 | 0.87 |
| 0.781 | 0.219 | 0.317 | 0.87 |
| 0.702 | 0.298 | 0.356 | 0.88 |
| 0.600 | 0.400 | 0.392 | 0.89 |
| 0.547 | 0.453 | 0.410 | 0.90 |
| 0.499 | 0.501 | 0.411 | 0.91 |
| 0.458 | 0.542 | 0.415 | 0.92 |
| 0.407 | 0.593 | 0.404 | 0.91 |

Additional data for the miscibility of alcohol with chloroform + water mixtures are given by Miller and McPherson, 1908.

MISCIBILITY OF ETHYL ALCOHOL WITH MIXTURES OF ETHYL ETHER AND WATER AT 0°. (Corliss, 1914; Bonner, 1910; see also Kremann, 1910a.)

| Composition of the Lower Layer. | | | | Composition of Upper Layer. | | | |
|---|---|---|---|---|---|---|---|
| Gms. $(C_2H_5)_2O$. | Gms. $H_2O$. | Gms. $C_2H_5OH$. | Sp. Gr. Sat. Sol. | Gms. $(C_2H_5)_2O$. | Gms. $H_2O$. | Gms. $C_2H_5OH$. | Sp. Gr. Sat. Sol. |
| 0.10 | 0.90 | 0.163 | 0.970 | ... | ... | ... | ... |
| ... | ... | ... | ... | 0.957 | 0.043 | 0.151 | 0.757 |
| 0.16 | 0.84 | 0.297 | 0.951 | 0.902 | 0.098 | 0.230 | 0.778 |
| 0.178 | 0.822 | 0.318 | 0.945 | 0.87 | 0.13 | 0.26 | 0.788 |
| 0.192 | 0.808 | 0.332 | 0.941 | 0.85 | 0.15 | 0.275 | 0.794 |
| 0.204 | 0.796 | 0.34 | 0.937 | 0.825 | 0.175 | 0.292 | 0.800 |
| 0.227 | 0.773 | 0.352 | 0.932 | 0.79 | 0.210 | 0.313 | 0.808 |
| 0.250 | 0.75 | 0.36 | 0.926 | 0.759 | 0.243 | 0.33 | 0.815 |
| 0.293 | 0.707 | 0.37 | 0.916 | 0.70 | 0.30 | 0.35 | 0.827 |
| 0.335 | 0.665 | 0.375 | 0.906 | 0.645 | 0.355 | 0.366 | 0.839 |
| 0.422 | 0.578 | 0.385 | 0.886 | 0.562 | 0.438 | 0.385 | 0.857 |
| *0.49 | 0.51 | 0.385 | 0.874 | 0.49 | 0.51 | 0.385 | 0.874 |

The data for the binodal curve given by Corliss and by Bonner agree closely. The Sp. Gr. determinations of Corliss were made on larger amounts of solution and appear to be the more accurate. In addition, Corliss gives the specific gravities of each layer of a series of liquids in contact with each other, and from these and the binodal curve, the above data for the composition of the several conjugate layers have been calculated. Data are also given by Corliss for the distribution of colloidal arsenious sulfide between the two layers of the system.

Data for the distribution of ethyl alcohol between ether and water and between ether and molten $CaCl_2.6H_2O$ are given by Morgan and Benson (1907).

MISCIBILITY OF ETHYL ALCOHOL WITH MIXTURES OF ETHYL ETHER AND WATER AT 25°. (Horiba, 1911-12.)

| Composition of Lower Layer. | | | Composition of Upper Layer. | | |
|---|---|---|---|---|---|
| Gms. $(C_2H_5)_2O$. | Gms. $H_2O$. | Gms. $C_2H_5OH$. | Gms. $(C_2H_5)_2O$. | Gms. $H_2O$. | Gms. $C_2H_5O_2H$. |
| 5.77 | 94.23 | 0 | 98.72 | 1.28 | 0 |
| 6.3 | 85.7 | 8 | 94.5 | 2.2 | 3.3 |
| 7.2 | 79.2 | 13.6 | 88.5 | 3.7 | 7.8 |
| 8 | 76 | 16 | 84.4 | 4.9 | 10.7 |
| 9.7 | 70.4 | 19.9 | 75.1 | 8.4 | 16.5 |
| 13.3 | 62.8 | 23.9 | 60.8 | 15.5 | 23.7 |
| 22.1 | 50.6 | 27.3 | 43.8 | 28.1 | 28.1 |
| 28.4 | 43.4 | 28.2 | 35.8 | 35.6 | 28.6 |
| *31.6 | 40 | 28.4 (Plait point) | 31.6 | 40 | 28.4 |

The binodal curve was determined in the usual way (see Note, p. 4 ). A series of conjugate liquids was then prepared and the Sp. Gr., refractive index and viscosity of each layer determined. From specially prepared curves for variations of physical constants with composition of mixture, the composition of the several conjugate liquids was ascertained. The results thus obtained, are given in the above table.

Data for the miscibility of ethyl alcohol with mixtures of water, ethyl ether and sulfuric acid at 0° and with mixtures of ethyl ether, water and ethylsulfuric acid at 0° are given by Kremann, 1910a.

MISCIBILITY OF ETHYL ALCOHOL (see Note p. 4 ) AT 0° WITH MIXTURES OF:

Ethyl Acetate and Water. (Bonner, 1910.)

| Composition of Homogeneous Mixtures. | | | |
|---|---|---|---|
| Gms. $CH_3COOC_2H_5$. | Gms. $H_2O$. | Gms. $C_2H_5OH$. | Sp. Gr. Sat. Sol. |
| 0.92 | 0.080 | 0.100 | 0.91 |
| 0.90 | 0.10 | 0.13 | 0.91 |
| 0.799 | 0.201 | 0.228 | 0.93 |
| 0.699 | 0.301 | 0.265 | 0.92 |
| 0.60 | 0.40 | 0.29 | 0.95 |
| 0.50 | 0.50 | 0.30 | 0.95 |
| *0.48 | 0.52 | 0.30 | ... |
| 0.40 | 0.60 | 0.31 | 0.96 |
| 0.30 | 0.70 | 0.31 | 0.96 |
| 0.197 | 0.803 | 0.282 | 0.97 |
| 0.102 | 0.898 | 0.143 | 0.99 |

Ethyl Bromide and Water. (Bonner, 1910.)

| Composition of Homogeneous Mixtures. | | | |
|---|---|---|---|
| Gms. $C_2H_5Br$. | Gms. $H_2O$. | Gms. $C_2H_5OH$. | Sp. Gr. Sat. Sol. |
| 0.967 | 0.033 | 0.240 | 1.23 |
| 0.90 | 0.10 | 0.37 | 1.15 |
| *0.83 | 0.17 | 0.45 | ... |
| 0.80 | 0.20 | 0.51 | 1.09 |
| 0.70 | 0.30 | 0.64 | 1.06 |
| 0.60 | 0.40 | 0.754 | 1.03 |
| 0.50 | 0.50 | 0.83 | 1 |
| 0.40 | 0.60 | 0.89 | 0.99 |
| 0.30 | 0.70 | 0.89 | 0.97 |
| 0.10 | 0.90 | 0.73 | 0.97 |
| 0.017 | 0.983 | 0.182 | 0.99 |

MISCIBILITY OF ETHYL ALCOHOL (see Note p. 4 ) AT 0°, WITH MIXTURES OF:

Ethyl Butyrate and Water. (Bonner, 1910.)

| Composition of Homogeneous Mixtures. | | | |
|---|---|---|---|
| Gms. $C_3H_7COOC_2H_5$. | Gms. $H_2O$. | Gms. $C_2H_5OH$. | Sp.Gr. Sat. Sol. |
| 0.97 | 0.030 | 0.166 | 0.96 |
| 0.90 | 0.10 | 0.32 | ... |
| 0.80 | 0.20 | 0.483 | 0.88 |
| 0.70 | 0.30 | 0.567 | 0.89 |
| 0.599 | 0.401 | 0.628 | 0.90 |
| 0.494 | 0.506 | 0.659 | 0.91 |
| *0.46 | 0.54 | 0.67 | ... |
| 0.40 | 0.60 | 0.69 | 0.92 |
| 0.297 | 0.703 | 0.693 | 0.93 |
| 0.193 | 0.807 | 0.684 | 0.94 |
| 0.10 | 0.90 | 0.63 | 0.94 |

Ethyl Propionate and Water. (Bonner, 1910.)

| Composition of Homogeneous Mixtures. | | | |
|---|---|---|---|
| Gms. $C_2H_5COOC_2N_5$. | Gms. $H_2O$. | Gms. $C_2H_5OH$. | Sp. Gr. Sat. Sol. |
| 0.977 | 0.023 | 0.138 | 0.90 |
| 0.90 | 0.10 | 0.27 | 0.90 |
| 0.80 | 0.20 | 0.38 | 0.90 |
| 0.695 | 0.305 | 0.453 | 0.92 |
| 0.60 | 0.40 | 0.49 | 0.91 |
| 0.50 | 0.50 | 0.52 | 0.92 |
| *0.46 | 0.54 | 0.53 | ... |
| 0.398 | 0.602 | 0.532 | 0.93 |
| 0.30 | 0.70 | 0.55 | 0.94 |
| 0.201 | 0.799 | 0.517 | 0.95 |
| 0.10 | 0.90 | 0.46 | 0.96 |

## ETHYL ALCOHOL

### EQUILIBRIUM IN THE SYSTEM ETHYL ALCOHOL, ETHYL ETHER AND WATER.

(Leland, 1934.)

The following results are given for the freezing-points of:

| $C_2H_5OH + (C_2H_5)_2O$ | | | | $(C_2H_5)_2O + H_2O$ | | | |
|---|---|---|---|---|---|---|---|
| t° | Wt. % $C_2H_5OH$ | t° | Wt. % $C_2H_5OH$ | t° | Wt. % $C_2H_5OH$ | t° | Wt. % $C_2H_5OH$ |
| -116.3 | 0.0 | -123.0 | 49.2 | -0.24 | 1.0 | -2.20 | 8.10 |
| -117.3 | 4.0 | -125.0 Eutec | 57.8 | -0.50 | 2.07 | -2.40 | 8.75 |
| -117.7 | 7.4 | -123.4 | 64.5 | -0.78 | 3.05 | -2.62 | 10.08 |
| -118.3 | 13.5 | -121.5 | 72.0 | -1.00 | 3.80 | -3.22 | 11.50 |
| -119.2 | 22.1 | -119.2 | 80.2 | -1.29 | 5.0 | -3.38 | 11.95 |
| -120.0 | 31.3 | -117.8 | 87.1 | -1.54 | 5.92 | -3.45 | 12.03 |
| -121.3 | 39.2 | -114.5 | 100.0 | -1.79 | 6.79 | -3.78 tr.pt. | 12.85 |

The author then gives the freezing-points of a series of mixtures of $C_2H_5OH + H_2O$ to which increasing amounts of $(C_2H_5)_2O$ were added and obtains the following values for the line of the quadruple points.

| t° | Gms. per 100 gms. Mixture | | t° | Gms. per 100 gms. Mixture | |
|---|---|---|---|---|---|
| | $C_2H_5OH$ | $(C_2H_5)_2O$ | | $C_2H_5OH$ | $(C_2H_5)_2O$ |
| - 3.78 | 0.0 | 12.8 | -21.65 | 27.4 | 33.8 |
| - 5.95 | 4.0 | 12.6 | -21.56 | 26.95 | 45.65 |
| - 8.4 | 7.8 | 12.3 | -20.63 | 22.2 | 63.23 |
| -12.86 | 14.2 | 12.2 | -16.5 | 9.8 | 85.6 |
| -17.95 | 20.8 | 14.2 | - 8.0 | 1.7 | 96.8 |
| -21.5 | 27.1 | 23.5 | - 3.7 | 0.0 | 99.1 |

The author also gives results for the densities at 0° of binary and ternary mixtures of $C_2H_5OH$, $(C_2H_5)_2O$ and $H_2O$, which together with chemical determinations of $(C_2H_5)_2O$ serve for the analysis of ternary mixtures.

### EQUILIBRIUM IN THE SYSTEM ETHYL ALCOHOL, ETHYL ETHER AND WATER AT 20°

(Bancroft, 1895.)

| Per 5.0 cc $C_2H_5OH$ | |
|---|---|
| cc $H_2O$ (1) | cc $(C_2H_5)_2O$ (2) |
| 50 | 1.30 |
| 25 | 1.70 |
| 10 | 2.41 |
| 8 | 3.35 |
| 6 | 5.10 |
| 5.21 | 6 |

(1) Saturated with $(C_2H_5)_2O$

| Per 5.0 cc $C_2H_5OH$ | |
|---|---|
| cc $H_2O$ (1) | cc $(C_2H_5)_2O$ (2) |
| 4.45 | 7 |
| 4.0 | 7.8 |
| 3.87 | 8 |
| 3.10 | 10 |
| 2.08 | 15 |
| 1.77 | 17.5 |

(2) Saturated with $H_2O$

# ETHYL ALCOHOL

## Equilibrium in the System Ethyl Alcohol, Ethyl Acetate and Water.

(Beech and Glasstone, 1938.)

The solubility (binodal) curve was determined by the titration method. The compositions of conjugate layers were determined by preparing mixtures of known amounts of the three constituents and analyzing the upper layer for acetate. These results and the solubility curve fix the tie lines. The points of intersection of the tie lines with the binodal curve correspond to the solutions in contact with each other.

| t° | Gms. per 100 gms. lower layer | | | Gms. per 100 gms. upper layer | | |
|---|---|---|---|---|---|---|
| | $H_2O$ | $CH_3COOC_2H_5$ | $C_2H_5OH$ | $H_2O$ | $CH_5COOC_2H_5$ | $C_2H_5OH$ |
| 0 | 86.9 | 9.3 | 3.8 | 2.4 | 97.5 | 0.1 |
| " | 84.2 | 9.1 | 6.7 | 2.9 | 95.6 | 1.5 |
| " | 80.2 | 9.0 | 10.8 | 3.6 | 93.1 | 3.3 |
| " | 76.9 | 9.2 | 13.9 | 4.6 | 89.6 | 5.8 |
| " | 73.8 | 9.7 | 16.5 | 6.7 | 84.1 | 9.2 |
| " | 68.9 | 11.3 | 19.8 | 10.7 | 75.9 | 13.4 |
| 20 | 88.1 | 7.9 | 4.0 | 3.6 | 94.4 | 2.0 |
| " | 84.0 | 8.4 | 7.6 | 5.3 | 89.2 | 5.5 |
| " | 80.4 | 9.2 | 10.4 | 7.0 | 85.2 | 7.8 |
| " | 75.6 | 10.7 | 13.7 | 8.6 | 81.2 | 10.2 |
| " | 70.5 | 13.0 | 16.5 | 13.4 | 72.1 | 14.5 |
| " | 62.6 | 17.9 | 19.5 | 21.3 | 60.4 | 18.3 |

## Equilibrium in the System Ethyl Alcohol, Ethyl Acetate and Water at 20°.

(Bancroft, 1895.)

| Per 1 cc $C_2H_5OH$ | |
|---|---|
| cc $H_2O$ (1) | cc $CH_3COOC_2H_5$ (2) |
| 10 | 0.25 |
| 8 | 0.27 |
| 4 | 0.35 |
| 2 | 1.12 |

(1) Saturated with $CH_3COOC_2H_5$

| Per 1 cc $C_2H_5OH$ | |
|---|---|
| cc $H_2O$ (1) | cc $CH_3COOC_2H_5$ (2) |
| 1.06 | 2.50 |
| 0.69 | 5 |
| 0.54 | 7 |
| 0.44 | 10 |

(2) Saturated with $H_2O$

## Reciprocal Solubility of Ethyl Alcohol and Nitroglycerol.

(Copeman, 1936.)

The determinations were made by the titration method using Ethyl Alcohol of $d_{15} = 0.812 = 93.9$ wt. % $C_2H_5OH$ and filtered and dried Nitroglycerol of $d_{25} = 1.591$, determined by hydrometer. In the case of the solubility of alcohol in nitroglycerol the end point was that at which a faint permanent opalescence remained after long shaking. In the reverse case the end point was that at which the mixture just became clear on shaking.

| t° | Solubility in terms of Wt. Percent of: | | t° | Solubility in terms of Wt. Percent of: | |
|---|---|---|---|---|---|
| | Alcohol in Nitroglycerol | Nitroglycerol in Alcohol | | Alcohol in Nitroglycerol | Nitroglycerol in Alcohol |
| 15 | 3.2 | 25.0 | 30 | 5.9 | 32.9 |
| 20 | 3.9 | 27.3 | 32 | — | 34.3 |
| 25 | 4.85 | 30.0 | 35 | 7.4 | 36.7 |
| 28 | — | 31.8 | 40 | 9.7 | 41.4 |

## Equilibrium in the System Normal Butyl Alcohol, Ethyl Alcohol and Water. (Drouillon, 1925.)

The synthetic method was used. Known mixtures were heated in sealed tubes to complete solution of the three constituents and then cooled slowly, while being shaken, untill clouding appeared. A series of aqueous-ethyl alcohol mixtures were prepared and to each of these, increasing amounts of normal butyl alcohol were added and the temperatures of complete solution determined. The results were plotted and the following values for the isothermal curves were obtained.

| Gms. $C_2H_5OH$ per 100 gms. $H_2O+C_2H_5OH$ mixture. | Gms. $CH_3(CH_2)_2CH_2OH$ per 100 gms. sat. sol. at 20°. | | 40°. | | 60°. | | 80°. | | 100°. | | 120°. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Butyl alcohol Phase. | Water Phase. | Butyl alcohol Phase. | Water Phase. | Butyl alcohol Phase. | Water Phase. | Butyl alcohol Phase. | Water Phase. | Butyl alcohol Phase. | Water Phase. | Butyl alcohol Phase. | Water Phase. |
| 0.0 (= Water. | 81.6 | 6.6 | 80.3 | 6.0 | 78.5 | 5.5 | 74.6 | 6.4 | 68.8 | 7.5 | 57.3 | 11.8 |
| 2.49..... | 81.1 | 6.8 | 79.6 | 6.3 | 77.0 | 6.2 | 73.1 | 7.1 | 68.8 | 10.3 | 49.2 | 26.5 |
| 5.02..... | – | 7.1 | – | 6.7 | 75.9 | 7.3 | 72.0 | 8.6 | 64.2 | 16.2 | | |
| 7.51..... | – | 7.4 | – | 7.7 | 74.0 | 8.5 | 69.7 | 12.8 | 59.4 | 28.9 | | |
| 10.09..... | 78.2 | 8.2 | 76.4 | 8.9 | 73.3 | 12.4 | 67.5 | 21.0 | | 47.0 | | |
| 12.06..... | – | 10.7 | – | 11.6 | 71.5 | 17.5 | 64.8 | 28.5 | | | | |
| 15.39..... | – | 15.8 | 72.7 | 20.5 | 68.0 | 28.5 | 57.8 | 41.5 | | | | |
| 17.54..... | 74.7 | 19.4 | 71.0 | 24.4 | 66.1 | 33.6 | | | | | | |
| 20.0..... | 73.3 | 24.0 | 68.9 | 31.3 | 62.3 | 40.5 | | | | | | |
| 22.5..... | 69.7 | 32.3 | 64.5 | 40.1 | | | | | | | | |
| 24.99..... | 65.7 | 40.4 | | | | | | | | | | |

The author also gives data from which the composition of a series of conjugated layers at 20° can be estimated.

## Equilibrium in the System Ethyl Alcohol Methyl Butyrate and Water at 20°.

(Bancroft, 1895, from Pfeiffer, 1892.)

| Per 3.0 cc $CH_3(CH_2)_2COOCH_3$ | |
|---|---|
| cc $H_2O$ | cc $C_2H_5OH$ |
| 2.34 | 3 |
| 6.96 | 6 |
| 12.62 | 9 |
| 19.45 | 12 |
| 28.13 | 15 |
| 38.80 | 18 |
| 54.64 | 21 |
| ∞ | 24 |

The distribution coefficient of ethyl alcohol between water and amyl alcohol was found by Fontein (1910) to be 1.13 at 15.5° and 1.21 at 28°.

## Equilibrium in the System Ethyl Alcohol, Methyl Valerate and Water at 20°.

(Bancroft, 1895, from Pfeiffer, 1892.)

| Per 3 cc $C_4H_9COOCH_3$ | |
|---|---|
| cc $H_2O$ | cc $C_2H_5OH$ |
| 1.66 | 3 |
| 5.06 | 6 |
| 9.03 | 9 |
| 13.40 | 12 |
| 18.41 | 15 |
| 24 | 18 |
| 30.09 | 21 |
| 36.72 | 24 |
| 44.15 | 27 |
| 52.37 | 30 |
| 62.25 | 33 |
| 74.15 | 36 |
| 91.45 | 39 |
| ∞ | 42 |

MISCIBILITY OF ETHYL ALCOHOL (see Note, p. 4 ) AT 0° WITH MIXTURES OF:

Isoamyl Alcohol and Water.
(Bonner, 1910.)

Composition of Homogeneous Mixtures.

| Gms. $(CH_3)_2$-$CH(CH_2)_2OH$. | Gms. $H_2O$. | Gms. $C_2H_5OH$. | Sp. Gr. Sat. Sol. |
|---|---|---|---|
| 0.903 | 0.097 | 0.116 | 0.84 |
| 0.90 | 0.10 | 0.12 | 0.84 |
| 0.797 | 0.203 | 0.258 | 0.85 |
| 0.694 | 0.306 | 0.396 | 0.86 |
| 0.602 | 0.398 | 0.427 | 0.88 |
| 0.497 | 0.503 | 0.449 | 0.89 |
| 0.399 | 0.601 | 0.453 | 0.90 |
| 0.294 | 0.706 | 0.434 | 0.92 |
| *0.27 | 0.73 | 0.43 | ... |
| 0.196 | 0.804 | 0.411 | 0.94 |
| 0.10 | 0.900 | 0.369 | 0.96 |

Isobutyl Alcohol and Water.
(Bonner, 1910.)

Composition of Homogeneous Mixtures.

| Gms. $(CH_3)_2$-$CH\,CH_2OH$. | Gms. $H_2O$. | Gms. $C_2H_5OH$. | Sp. Gr. Sat. Sol. |
|---|---|---|---|
| 0.70 | 0.30 | 0.13 | 0.87 |
| 0.589 | 0.411 | 0.177 | 0.89 |
| 0.502 | 0.498 | 0.194 | 0.90 |
| 0.50 | 0.50 | 0.20 | 0.90 |
| 0.40 | 0.60 | 0.20 | 0.92 |
| 0.387 | 0.613 | 0.204 | 0.92 |
| *0.35 | 0.65 | 0.21 | ... |
| 0.304 | 0.696 | 0.205 | 0.94 |
| 0.30 | 0.70 | 0.21 | 0.94 |
| 0.20 | 0.80 | 0.20 | 0.95 |
| 0.132 | 0.868 | 0.189 | 0.96 |

MISCIBILITY OF ETHYL ALCOHOL (see Note, p. 4 ) AT 0° WITH MIXTURES OF:

Isoamyl Bromide and Water. (Bonner, '10.)

Composition of Homogeneous Mixtures.

| Gms. $C_5H_{11}Br$. | Gms. $H_2O$. | Gms. $C_2H_5OH$. | Sp. Gr. Sat. Sol. |
|---|---|---|---|
| 0.975 | 0.025 | 0.251 | 1.10 |
| *0.96 | 0.04 | 0.36 | ... |
| 0.90 | 0.10 | 0.68 | 1.01 |
| 0.80 | 0.20 | 1.09 | 0.96 |
| 0.70 | 0.30 | 1.37 | 0.94 |
| 0.60 | 0.40 | 1.57 | 0.93 |
| 0.498 | 0.502 | 1.676 | 0.91 |
| 0.40 | 0.60 | 1.75 | 0.91 |
| 0.30 | 0.70 | 1.75 | 0.91 |
| 0.20 | 0.80 | 1.71 | 0.91 |
| 0.10 | 0.90 | 1.46 | 0.92 |
| 0.022 | 0.978 | 1.027 | 0.93 |

Isobutyl Bromide and Water. (Bonner, '10.)

Composition of Homogeneous Mixtures.

| Gms. $(CH_3)_2$-$CHCH_2Br$. | Gms. $H_2O$. | Gms. $C_2H_5OH$. | Sp. Gr. Sat. Sol. |
|---|---|---|---|
| 0.976 | 0.024 | 0.200 | 1.18 |
| *0.93 | 0.07 | 0.42 | ... |
| 0.90 | 0.10 | 0.52 | 1.09 |
| 0.80 | 0.20 | 0.83 | 1.01 |
| 0.70 | 0.30 | 1.05 | 0.98 |
| 0.60 | 0.40 | 1.21 | 0.96 |
| 0.501 | 0.499 | 1.30 | 0.94 |
| 0.40 | 0.60 | 1.35 | 0.93 |
| 0.30 | 0.70 | 1.36 | 0.93 |
| 0.20 | 0.80 | 1.32 | 0.92 |
| 0.10 | 0.90 | 1.20 | 0.93 |
| 0.047 | 0.953 | 0.937 | 0.94 |

MISCIBILITY OF ETHYL ALCOHOL (see Note, p. 4 ) AT 0° WITH MIXTURES OF:

Isoamyl Ether and Water. (Bonner, '10.)

Composition of Homogeneous Mixtures.

| Gms. $[(CH_3)_2$-$CH.CH_2CH_2]_2O$. | Gms. $H_2O$. | Gms. $C_2H_5OH$. | Sp. Gr. Sat. Sol. |
|---|---|---|---|
| 0.958 | 0.042 | 0.368 | 0.81 |
| 0.90 | 0.10 | 0.70 | 0.82 |
| *0.89 | 0.11 | 0.74 | ... |
| 0.879 | 0.121 | 0.793 | 0.82 |
| 0.80 | 0.20 | 1.20 | 0.83 |
| 0.702 | 0.298 | 1.573 | 0.83 |
| 0.594 | 0.406 | 1.876 | 0.84 |
| 0.50 | 0.50 | 1.98 | 0.84 |
| 0.40 | 0.60 | 2.19 | 0.85 |
| 0.302 | 0.698 | 2.24 | 0.86 |
| 0 20 | 0.80 | 2.14 | 0.87 |
| 0.10 | 0.90 | 1.87 | 0.89 |

Mesitylene and Water. (Bonner, '10.)

Composition of Homogeneous Mixtures.

| Gms. $C_6H_3(CH_3)_3$. | Gms. $H_2O$. | Gms. $C_2H_5OH$. | Sp. Gr. Sat. Sol. |
|---|---|---|---|
| *0.97 | 0.03 | 0.48 | ... |
| 0.963 | 0.037 | 0.516 | 0.86 |
| 0.90 | 0.10 | 1.09 | 0.85 |
| 0.80 | 0.20 | 1.66 | 0.84 |
| 0.70 | 0.30 | 2.04 | 0.85 |
| 0.60 | 0.40 | 2.32 | 0.85 |
| 0.50 | 0.50 | 2.52 | 0.85 |
| 0.40 | 0.60 | 2.64 | 0.86 |
| 0.30 | 0.70 | 2.68 | 0.87 |
| 0.199 | 0.801 | 2.49 | 0.87 |
| 0.10 | 0.90 | 2.28 | 0.89 |
| 0.051 | 0.949 | 1.615 | 0.90 |

## Composition of the Conjugate Layers in the System Ethyl Alcohol, Benzene and Water.

(Tarassenkow and Pologieuzewa, 1932.)

| t° | Gms. per 100 gms. upper layer | | | Gms. per 100 gms. lower layer | | |
|---|---|---|---|---|---|---|
| | $C_6H_6$ | $C_2H_5OH$ | $H_2O$ | $C_6H_6$ | $C_2H_5OH$ | $H_2O$ |
| 0 | 97.02 | 2.28 | 0.70 | 0.86 | 39.77 | 59.36 |
| " | 93.00 | 5.04 | 1.96 | 4.94 | 48.58 | 46.48 |
| " | 90.59 | 7.22 | 2.11 | 12.60 | 53.32 | 34.08 |
| " | 40.97 | 48.87 | 10.16 | 73.10 | 25.25 | 1.65 |
| " | 30.35 | 50.44 | 19.21 | 88.40 | 14.17 | 2.43 |
| " | 27.35 | 50.13 | 22.58 | 83.53 | 14.04 | 1.83 |
| " | 26.59 | 53.30 | 20.21 | 85.00 | 11.94 | 3.06 |
| " | 24.82 | 52.51 | 22.67 | 84.91 | 11.90 | 3.11 |
| " | 22.14 | 60.75 | 25.11 | 86.20 | 10.30 | 3.44 |
| 20 | 97.14 | 1.61 | 1.25 | 0.10 | 28.07 | 71.83 |
| " | 88.63 | 8.55 | 2.82 | 6.91 | 48.09 | 45.00 |
| " | 83.92 | 12.77 | 3.81 | 15.84 | 51.54 | 32.62 |
| " | 75.48 | 19.14 | 5.38 | 31.64 | 46.80 | 21.56 |
| " | 72.49 | 22.34 | 5.17 | 35.61 | 45.49 | 18.90 |
| " | 67.94 | 25.85 | 6.31 | 44.71 | 41.79 | 13.50 |
| 40 | 94.49 | 4.12 | 1.39 | 0.91 | 29.07 | 70.02 |
| " | 89.70 | 8.26 | 2.04 | 3.50 | 39.59 | 56.91 |
| " | 87.22 | 9.07 | 3.71 | 4.73 | 40.09 | 55.18 |
| " | 79.12 | 16.22 | 4.61 | 14.79 | 47.10 | 38.11 |
| " | 71.76 | 22.07 | 6.17 | 26.18 | 46.80 | 27.02 |
| " | 66.03 | 26.64 | 7.33 | 33.71 | 44.38 | 22.41 |
| " | 63.75 | 28.26 | 7.99 | 36.59 | 41.90 | 22.51 |
| " | 60.01 | 30.48 | 9.51 | 38.98 | 40.84 | 20.18 |

## Equilibrium in the System Ethyl Alcohol, Benzene and Water at 25°.

(Washburn, Hnizda and Vold, 1931.)

The binodal curve was determined by titrating mixtures of ethyl alcoho and benzene with water to permanent cloudiness. The refractive indices of the saturated solutions were also determined as well as of separately prepared conjugate layers. From these results tie lines were located.

| Gms. per 100 gms. sat. sol. | | Gms. per 100 gms. sat. sol. | | Gms. per 100 gms. sat. sol. | |
|---|---|---|---|---|---|
| $C_2H_5OH$ | $C_6H_6$ | $C_2H_5OH$ | $C_6H_6$ | $C_2H_5OH$ | $C_6H_6$ |
| 8.2 | 91.1 | 29.1 | 64.6 | 51.8 | 23.0 |
| 10.0 | 89.0 | 34.3 | 57.0 | 51.2 | 11.4 |
| 12.9 | 85.7 | 41.6 | 46.2 | 46.6 | 5.1 |
| 17.9 | 79.5 | 44.8 | 39.8 | 37.4 | 2.1 |
| 25.3 | 70.2 | 50.4 | 27.9 | 29.9 | 0.83 |
| | | | | 25.8 | 0.57 |

Similar determinations at 21 made by Perrakis, 1925, gave the following results:

| Wt. % $C_2H_5OH$ in $C_2H_5OH + C_6H_6$ mixture (A) | Gms. $H_2O$ to cause clouding of 100 gms. mixture(A) | Wt. % $C_2H_5OH$ in $C_2H_5OH + C_6H_6$ mixture (A) | Gms. $H_2O$ to cause clouding of 100 gms. mixture(A) |
|---|---|---|---|
| 15.87 | 0.9930 | 33.33 | 5.5077 |
| 20.28 | 1.8817 | 35.41 | 6.0985 |
| 23.50 | 2.7093 | 37.02 | 6.6902 |
| 26.45 | 3.4722 | 38.38 | 7.2826 |
| 28.75 | 4.2046 | 45.57 | 10.2794 |
| 30.92 | 4.9000 | | |

Previous determinations of the binodal curve of this system and the distribution coefficients of ethyl alcohol between water and benzene are given by Bancroft, 1895; Taylor, 1897; Lincoln, 1900; Morgan and Benson, 1907; Bonner, 1910 and Bubanovic, 1913.

## Equilibrium in the System Benzene, Ethyl Alcohol and Water.

(Wehrmann, 1921.)

To given volumes of mixtures of alcohol and water of known percentage composition, as determined by specific gravity, benzene was added from a buret untill clouding occurred.

| t°. | Per cent $C_2H_5OH$ in Aq. Alcohol employed. | Composition of the mixture in vol. per cent at the point of Clouding. $C_6H_6$. | $C_2H_5OH$. | $H_2O$. |
|---|---|---|---|---|
| —10.... | 40 | 0.5 | 42.1 | 57.4 |
| —10.... | 60 | 3.9 | 59.5 | 36.6 |
| —10.... | 70 | 10.2 | 63.7 | 26.1 |
| —10.... | 80 | 20.0 | 63.5 | 16.5 |
| —10.... | 90 | 52.8 | 42.4 | 4.8 |
| ± 0.... | 10 | 0.32 | 10.38 | 89.3 |
| ± 0.... | 30 | 0.37 | 26.83 | 72.8 |
| ± 0.... | 40 | 0.9 | 40.9 | 58.2 |
| ± 0.... | 50 | 2.5 | 51.2 | 46.3 |
| ± 0.... | 60 | 4.55 | 57.9 | 37.55 |
| ± 0.... | 70 | 12.6 | 61.4 | 26.0 |
| ± 0.... | 80 | 24.8 | 59.5 | 15.7 |
| ± 0.... | 90 | 63.5 | 32.7 | 3.8 |
| ± 0.... | 96 | 92.7 | 7.1 | 0.2 |
| +10.... | 40 | 1.4 | 40.8 | 57.8 |
| +10.... | 60 | 5.3 | 56.9 | 37.8 |
| +10.... | 70 | 14.5 | 60.0 | 25.5 |
| 10.... | 80 | 29.4 | 55.9 | 14.7 |
| 10.... | 90 | 68.0 | 28.7 | 3.3 |
| 20.... | 10 | 0.35 | 10.35 | 89.3 |
| 20.... | 30 | 0.95 | 26.65 | 72.4 |
| 20.... | 50 | 3.6 | 50.4 | 46.0 |
| 20.... | 60 | 7.2 | 55.7 | 37.1 |
| 20.... | 70 | 18.1 | 57.6 | 24.3 |
| 20.... | 80 | 33.7 | 52.2 | 14.1 |
| 20.... | 90 | 70.5 | 26.2 | 3.3 |
| 20.... | 96 | 98.5 | 1.46 | 0.04 |
| 30.... | 20 | 0.9 | 19.5 | 79.6 |
| 30.... | 40 | 2.6 | 40.2 | 57.2 |
| 30.... | 60 | 8.6 | 54.9 | 36.5 |
| 30.... | 70 | 18.9 | 57,0 | 24.1 |
| 30.... | 80 | 39.6 | 47.5 | 12.9 |
| 30.... | 90 | 74.0 | 23.3 | 2.7 |

## Equilibrium in the System Benzene, Ethyl Alcohol and Water.

(Sidgwick and Spurrell, 1929.)

Benzene was added to known mixtures of alcohol and water untill two layers appeared or benzene crystallized out. For the two liquid equilibrium, the point was taken at which, on slow cooling, sufficient turbidity was produced to obscure a bright object placed behind the liquid. The extensive series of results were plotted on cross section paper and from the curves the following values for definite temperatures were interpolated.

Wt. per cent $C_6H_6$ which yielded a second liquid layer (or crystallized benzene) when added to a mixture of $C_2H_5OH + H_2O$ containing.

| t°. | 100 wt.% $C_2H_5OH$. | 99.5 wt.% $C_2H_5OH$ | 98.0 wt.% $C_2H_5OH$. | 95.76 wt.% $C_2H_5OH$. | 90.06 wt.% $C_2H_5OH$. | 86.0 wt.% $C_2H_5OH$. | 80.1 wt.% $C_2H_5OH$. | 74.48 wt.% $C_2H_5OH$. | 69.08 wt.% $C_2H_5OH$. | 57.66 wt.% $C_2H_5OH$. |
|---|---|---|---|---|---|---|---|---|---|---|
| 25... | – | – | – | – | 87.22* | 73.25* | 59.41* | 41.32* | 27.46* | 12.61* |
| 15... | – | – | – | – | 85.05* | 70.95* | 55.00* | 35.10* | 23.38* | 10.47* |
| 5... | 99.48 | – | – | – | 83.05* | 67.65* | 46.92* | 29.81* | 20.08* | 8.95* |
| 4... | 97.57 | – | – | – | 82.95* | ÷ | 46 18* | 29.32* | 19.75* | 8.81* |
| 3... | 93.82 | 92.65 | 92.52 | 91.22 | 82.76* | – | 45.42* | 28.85* | 19.45* | 8.68* |
| 3. . | – | – | – | – | – | – | – | – | – | 8.61 |
| 2... | 87.90 | 85.28 | 85.06 | 82.64 | 71.90 | – | 39.24 | 26.00 | 17.70 | 8.21 |
| 2... | – | – | – | – | 82.55* | – | 44.50* | 28.46* | 19.10* | 8.55* |
| 1... | 80.89 | 78.36 | 76.58 | 72.78 | 59.80 | – | 33.15 | 23.60 | 16.45 | 7.86 |
| 1... | – | – | – | – | 82.35* | – | 43.70 | 27.95 | 18.78* | 8.44* |
| 0... | 74.08 | 71.87 | 69.25 | 65.03 | 52.01 | – | 29.85 | 21.74 | 15.35 | 7.53 |
| 0... | – | – | – | – | 82.10* | – | 43.08 | 27.59* | 18.48* | 8.32* |
| —1... | 67.79 | 66.45 | 63.93 | 59.48 | 46.39 | – | 27.34 | 20.11 | 14.25 | 7.22 |
| —2... | 62.87 | 61.70 | 59.62 | 55.07 | 42.00 | – | 25.40 | 18.93 | 13.27 | 6.92 |
| —3... | 59.10 | 57.54 | 56.00 | 51.17 | 39.00 | – | 23.52 | 17.80 | 12.40 | 6.65 |
| —4. . | 55.56 | 54.49 | 52.71 | 47.82 | 37.48 | – | 22.21 | 16.75 | 11.56 | 6.38 |
| —5... | 52.60 | 51.85 | 49.90 | 44.81 | 34.45 | – | 21.00 | 15 82 | 10.80 | 6.12 |
| Triple pt... | – | – | – | 96.76 +4.10° | 82.62 +2.55° | 66.38 +2.52° | 44 95 +2.50° | 28 75 +2.64° | 19.28 +2.86° | 8.70 3.20° |

* Indicates two liquid layers. The results for 100 % $C_2H_5OH$ are from Pickering.

### Equilibrium in the System Benzene, Ethyl Alcohol and Water at 25° and at 60°. (Barbaudy, 1926.)

The clouding points were determined by adding mixtures of $C_2H_5OH + H_2O$ to mixtures of $C_2H_5OH + C_6H_6$ containing in both cases approximately the same $C_2H_5OH$ content.

Results at 25°.

Gms. per 100 gms. of mixture.

| $C_2H_5OH$. | $C_6H_6$. | $H_2O$. |
|---|---|---|
| 0.0 | 99.9 | 0.1 |
| 5.85 | 93.65 | 0.50 |
| 10.09 | 88.96 | 0.95 |
| 20.00 | 76.97 | 3.03 |
| 30.00 | 63.20 | 6.80 |
| 40.00 | 47.70 | 12.30 |
| 49.04 | 28.23 | 21.83 |
| 49.88 | 9.03 | 41.09 |
| 46.90 | 5.91 | 47.19 |
| 40.00 | 1.50 | 59.50 |
| 30.00 | 0.50 | 69.50 |

Results at 60°.

Gms. per 100 gms. of mixture.

| $C_2H_5OH$. | $C_6H_6$. | $H_2O$. |
|---|---|---|
| 0.0 | 0.23 | 99.77 |
| 36.58 | 4.08 | 59.34 |
| 40.81 | 6.91 | 52.28 |
| 43.84 | 10.74 | 45.42 |
| 45.22 | 16.95 | 37.83 |
| 46.13 | 20.76 | 33.11 |
| 43.84 | 29.97 | 26.19 |
| 40.00 | 41.46 | 18.54 |
| 34.78 | 52.39 | 12.83 |
| 26.96 | 65.54 | 7.50 |
| 17.87 | 78.60 | 3.53 |
| 0.00 | 99.75 | 0.25 |

In order to determine the conjugated solutions, mixtures were prepared to yield two layers and each of these were analyzed by determinations of density and index of refraction.

Composition of Conjugated Solutions at 25°.

| Upper layer. Gms. per 100 gms. | | | Lower layer. Gms. per 100 gms. | | |
|---|---|---|---|---|---|
| $C_2H_5OH$. | $C_6H_6$. | $H_2O$. | $C_2H_5OH$. | $C_6H_6$. | $H_2O$. |
| 1.35 | 98.54 | 0.11 | 17.5 | 0.0 | 82.5 |
| 3.18 | 96.54 | 0.24 | 30.7 | 0.55 | 68.75 |
| 5.29 | 94.37 | 0.34 | 36.0 | 0.90 | 63.1 |
| 34.1 | 51.05 | 8.85 | 40.85 | 46.25 | 12.9 |

Composition of Conjugated Solutions at 60°.

| Upper layer. Gms. per 100 gms. | | | Lower layer. Gms. per 100 gms. | | |
|---|---|---|---|---|---|
| $C_2H_5OH$. | $C_6H_6$. | $H_2O$. | $C_2H_5OH$. | $C_6H_6$. | $H_2O$. |
| 16.33 | 80.97 | 2.7 | 39.62 | 5.87 | 54.51 |
| 16.76 | 79.40 | 3.34 | 40.23 | 6.18 | 53.57 |
| 25.40 | 67.98 | 6.62 | 40.50 | 17.26 | 36.24 |
| 34.68 | 51.18 | 14.13 | 42.92 | 31.46 | 25.62 |
| 30.96 | 46.48 | 16.56 | 41.39 | 35.53 | 23.08 |

### Equilibrium in the System Benzene, Ethyl Alcohol and Water at 15°, 25° and 30°. (Ormandy and Craven, 1921.)

The benzene is given in per cent by weight in the mixture and the alcohol in weight per cent. The results therefore, show, for the points of clouding, the per cent by weight of benzene present in a mixture composed of benzene and aqueous alcohol of the particular weight per cent shown.

Results at 15°.

| Wt. % aq. Alcohol used. | Gms. $C_6H_6$ per 100 gms. final mixture. |
|---|---|
| 58.5 | 10 |
| 67.9 | 20 |
| 72.9 | 30 |
| 76.7 | 40 |
| 79.3 | 50 |
| 82.0 | 60 |
| 85.1 | 70 |
| 88.4 | 80 |
| 92.3 | 90 |

Results at 25°.

| Wt. % aq. Alcohol used. | Gms. $C_6H_6$ per 100 gms. final mixture. |
|---|---|
| 95.11 | 97.13 |
| 91.86 | 90.53 |
| 87.98 | 80.60 |
| 86.52 | 76.48 |
| 84.71 | 71.00 |
| 82.99 | 67.02 |
| 81.34 | 62.52 |
| 79.83 | 58.33 |
| 78.44 | 54.24 |
| 77.58 | 51.23 |

Results at 30°.

| Wt. % aq. Alcohol used. | Gms. $C_6H_6$ per 100 gms. final mixture. |
|---|---|
| 93.14 | 96.06 |
| 91.20 | 90.00 |
| 88.91 | 84.01 |
| 85.98 | 76.46 |
| 83.25 | 69.32 |
| 80.75 | 63.13 |
| 77.91 | 55.03 |
| 76.57 | 50.99 |
| 72.61 | 38.17 |
| 63.29 | 18.68 |

The results at 15° were read from the curve plotted from 30 determinations. They agree quite closely with similar determinations reported by Sidgwick and Spurrell, 1920; Taylor, 1897; and Bonner, 1910.

## Solubility of Benzene in Dilute Solutions of Ethyl Alcohol.

(Ormandy and Craven, 1922.)

A mechanical stirrer was used. Readings were taken at the point where turbidity was distinctly visible and at the point where the liquid became quite clear. The mean of these was taken as the true equilibrium point. The results, were plotted and the following table constructed from the curves.

| Strength of Alcohol in wt. % | Results for Benzene at 0°. | 15°. | 30°. | Results for Petrol A at 15°. | Results for Petrol + benzene (1:1) at 15°. |
|---|---|---|---|---|---|
| 0..... | 0.08 | 0.15 | – | 0.004 | – |
| 5..... | 0.08 | 0.15 | – | – | – |
| 10..... | 0.10 | 0.16 | – | – | – |
| 15..... | 0.13 | 0.19 | – | – | – |
| 20..... | 0.16 | 0.24 | – | – | – |
| 25..... | 0.24 | 0.38 | – | – | – |
| 30..... | 0.38 | 0.62 | 1.32 | 0.01 | 0.06 |
| 35..... | 0.62 | 1.02 | 1.88 | 0.04 | 0.12 |
| 40..... | 1.14 | 1.80 | 2.64 | 0.09 | 0.24 |
| 45..... | 1.80 | 3.00 | – | 0.20 | 0.45 |
| 50..... | – | – | – | 0.42 | – |

The figures show the percent by weight of benzene and petrol in the final equilibrium mixtures. It is evident from the results that benzene can be effectively removed from alcohol by dilution and extraction with petrol, hence, it is a rather poor denaturant for alcohol.

Data for equilibrium at — 15°, 0°, 15° and 30° in a system composed of 3 volumes of benzene + 1 volume of toluene (instead of benzene alone), alcohol and water, are given by Ormandy and Craven, 1921.

## Solubility of Benzene in : (Wright, 1926.)

| Aq. 50 wt. % $C_2H_5OH$. | | Aq. 50 wt. % $C_2H_5OH$ containing 5 % NaCl. | | Aq. 50 wt. % $C_2H_5OH$ containing $K_2CO_3$, at 20°. | | Aq. 50 wt. % $C_2H_5OH$ sat. with various salts at 20°. | |
|---|---|---|---|---|---|---|---|
| t°. | Gms. $C_6H_6$ per 100 gms. sat. sol. | t°. | Gms. $C_6H_6$ per 100 gms. sat. sol. | Per cent $K_2CO_3$. | Gms. $C_6H_6$ per 100 gms. sat. sol. | Salt. | Gms. $C_6H_6$ per 100 gms. sat. sol. |
| 1.2 | 4.57 | 9.1 | 5.80 | 1.12 | 6.4 | None | 5.8 |
| 3.2 | 4.78 | 11.8 | 6.10 | 1.67 | 6.5 | NaCl (10.6) | 9.6 |
| 15.5 | 5.05 | 14.2 | 6.39 | 2.18 | 7.1 | NaNO (21.2) | 9.5 |
| 18.0 | 5.30 | 16.7 | 6.76 | 2.48 | 7.3 | KCl (6.5) | 6.7 |
| 20.2 | 5.61 | 19.2 | 7.23 | 2.68 | 7.6* | $KNO_3$ (3.9) | 6.4 |
| 22.6 | 5.97 | 21.3 | 7.57 | 2.86 | 8.0 | KBr (17.4) | 7.8 |

*Two liquid layers form. The figures in parentheses show the grams of each salt per 100 gms. of sat. solution.

## Freezing-Points of Mixtures of Benzene and Aqueous Ethyl Alcohol.

(Ormandy and Craven, 1921.)

Results for benzene and :

| 99.3 wt. % $C_2H_5OH$. | | 90.3 wt. % $C_2H_5OH$. | | 80.3 wt. % $C_2H_5OH$. | | 70.3 wt. % $C_2H_5OH$. | |
|---|---|---|---|---|---|---|---|
| F. pt. | Gms. $C_6H_6$ per 100 gms. sat. sol. | F. pt. | Gms. $C_6H_6$ per 100 gms. sat. sol. | F. pt. | Gms. $C_6H_6$ per 100 gms. sat. sol. | F. pt. | Gms. $C_6H_6$ per 100 gms. sat. sol. |
| —11.4 | 38.4 | —10.2 | 26.9 | —11.8 | 15.1 | — 9.6 | 9.1 |
| —13.3 | 35.7 | —12.1 | 24.5 | —16.9 | 11.9 | —14.9 | 7.4 |
| —15.3 | 33.3 | —14.3 | 22.4 | —19.9 | 10.6 | | |
| —17.3 | 31.1 | —17.1 | 20.1 | —22.4 | 9.6 | | |
| —19.3 | 29.0 | —19.9 | 17.9 | —25.4 | 8.6 | | |
| —21.4 | 27.1 | —22.8 | 16.4 | —29.0 | 7.6 | | |
| —24.1 | 25.0 | —26.0 | 14.9 | —30.6 | 7.3 | | |
| —26.0 | 23.6 | —29.0 | 13.7 | | | | |
| —30.5 | 20.7 | —30.1 | 13.3 | | | | |

59.3 wt. % $C_2H_5OH$.

| F. pt. | Gms. $C_6H_6$ per 100 gms. sat. sol. | F. pt. | Gms. $C_6H_6$ per 100 gms. sat. sol. | F. pt. | Gms. $C_6H_6$ per 100 gms. sat. sol. |
|---|---|---|---|---|---|
| — 6.7 | 5.2 | —18.1 | 3.1 | —26.2 | 2.2 |
| —12.5 | 3.9 | —22.5 | 2.6 | —30.1 | 1.9 |

Data for the freezing-points of mixtures composed of benzene-toluene (3 : 1 by volume) alcohol and water are given by Ormandy and Craven, 1921.

Data for the solubility of mixtures of benzene and petrol in aqueous 92 wt. per cent ethyl alcohol at 20° are given by Ormandy and Craven, 1921.

Data for mixtures of Ethyl alcohol, benzene and glycerol and for mixtures of ethyl alcohol, benzene and lactic acid are given by Rozsa, 1911.

RECIPROCAL SOLUBILITY OF CHLORO BENZENE AND AQUEOUS ETHYL ALCOHOL.
(Rossett, Marange and Vinter, 1923.)

The temperatures were determined at which given mixtures just became clear or cloudy while being stirred in a test tube.

| t° of clouding. | Composition of mixture: cc. of $C_6H_5Cl$. | + | 5 cc. of aq. $C_2H_5OH$ of. |
|---|---|---|---|
| 66..... | 10 | | 87° |
| 34.5..... | 10 | | 88°.9 |
| 19.5..... | 10 | | 89°.8 |
| 7.5..... | 10 | | 90°.7 |

| t° of clouding. | Composition of mixture: cc. of $C_6H_5Cl$. | + | 5 cc. of aq. $C_2H_5OH$ of. |
|---|---|---|---|
| 28..... | 11 | | 89°.8 |
| 38..... | 12 | | 89°.8 |
| 44..... | 13 | | 89°.8 |
| 52..... | 14 | | 89°.8 |
| 60..... | 15 | | 89°.8 |

A few determinations are also given for mixtures of chlorobenzene + benzene in aqueous alcohol.

MISCIBILITY OF ETHYL ALCOHOL (see Note, p. 4 ) WITH MIXTURES OF:
Bromobenzene and Water at 0°.
(Bonner, 1910.)
Composition of Homogeneous Mixtures.

| Gms. $C_6H_5Br$. | Gms. $H_2O$. | Gms. $C_2H_5OH$. | Sp. Gr. Sat. Sol. |
|---|---|---|---|
| 0.99 | 0.010 | 0.115 | 1.34 |
| *0.96 | 0.040 | 0.32 | ... |
| 0.90 | 0.10 | 0.65 | 1.07 |
| 0.80 | 0.20 | 1 | 0.96 |
| 0.70 | 0.30 | 1.19 | 0.96 |
| 0.60 | 0.40 | 1.30 | 0.98 |
| 0.50 | 0.50 | 1.39 | 0.95 |
| 0.40 | 0.60 | 1.43 | 0.91 |
| 0.30 | 0.70 | 1.43 | 0.92 |
| 0.20 | 0.80 | 1.36 | 0.93 |
| 0.10 | 0.90 | 1.16 | 0.93 |
| 0.024 | 0.976 | 0.803 | 0.92 |

Nitrobenzene and Water at 15°.
(Bonner, 1910.)
Composition of Homogeneous Mixtures.

| Gms. $C_6H_5NO_2$. | Gms. $H_2O$. | Gms. $C_2H_5OH$. | Sp. Gr. Sat. Sol. |
|---|---|---|---|
| 0.965 | 0.035 | 0.248 | 1.08 |
| *0.91 | 0.09 | 0.49 | ... |
| 0.90 | 0.10 | 0.53 | 1.02 |
| 0.80 | 0.20 | 0.86 | 0.97 |
| 0.70 | 0.30 | 1.09 | 0.94 |
| 0.594 | 0.406 | 1.238 | 0.93 |
| 0.50 | 0.50 | 1.31 | 0.92 |
| 0.40 | 0.60 | 1.34 | 0.92 |
| 0.30 | 0.70 | 1.30 | 0.91 |
| 0.194 | 0.806 | 1.212 | 0.92 |
| 0.10 | 0.90 | 0.98 | 0.93 |
| 0.02 | 0.98 | 0.601 | 0.95 |

MISCIBILITY OF ETHYL ALCOHOL (see Note, p. 4 ) AT 0° WITH MIXTURES OF:
Benzyl Acetate and Water. (Bonner, 1910.)
Composition of Homogeneous Mixtures.

| Gms. $CH_3.CO_2.CH_2.C_6H_5$. | Gms. $H_2O$. | Gms. $C_2H_5OH$. | Sp. Gr. Sat. Sol. |
|---|---|---|---|
| 0.977 | 0.023 | 0.120 | 1.05 |
| 0.901 | 0.099 | 0.317 | 1.03 |
| 0.80 | 0.200 | 0.46 | 0.99 |
| 0.70 | 0.300 | 0.58 | 0.97 |
| *0.68 | 0.32 | 0.60 | ... |
| 0.60 | 0.40 | 0.69 | 0.95 |
| 0.50 | 0.50 | 0.78 | 0.94 |
| 0.40 | 0.60 | 0.85 | 0.94 |
| 0.30 | 0.70 | 0.88 | 0.93 |
| 0.20 | 0.80 | 0.88 | 0.93 |
| 0.10 | 0.90 | 0.80 | 0.94 |
| 0.041 | 0.959 | 0.665 | 0.95 |

Benzyl Alcohol and Water. (Bonner, 1910.)
Composition of Homogeneous Mixtures.

| Gms. $C_6H_5CH_2OH$. | Gms. $H_2O$. | Gms. $C_2H_5OH$. | Sp. Gr. Sat. Sol. |
|---|---|---|---|
| 0.90 | 0.10 | 0.13 | 1.03 |
| 0.80 | 0.20 | 0.26 | 1 |
| 0.70 | 0.30 | 0.35 | 0.98 |
| 0.60 | 0.40 | 0.39 | 0.98 |
| 0.50 | 0.50 | 0.40 | 0.97 |
| 0.40 | 0.60 | 0.41 | 0.97 |
| *0.38 | 0.62 | 0.42 | ... |
| 0.379 | 0.621 | 0.417 | 0.98 |
| 0.30 | 0.70 | 0.41 | 0.97 |
| 0.194 | 0.806 | 0.388 | 0.97 |
| 0.10 | 0.90 | 0.35 | 0.98 |
| 0.04 | 0.96 | 0.139 | 0.99 |

## Miscibility of Ethyl Alcohol at 0° with Mixtures of:

### Benzaldehyde and Water
(Bonner, 1910.)
Composition of Homogeneous Mixtures.

| Gms. $C_6H_5CHO$. | Gms. $H_2O$. | Gms. $C_2H_5OH$. | Sp. Gr. of Mixture. |
|---|---|---|---|
| 0.957 | 0.043 | 0.159 | 1.02 |
| 0.898 | 0.102 | 0.283 | 1.01 |
| 0.800 | 0.200 | 0.420 | 0.99 |
| 0.700 | 0.300 | 0.550 | 0.98 |
| 0.598 | 0.402 | 0.601 | 0.97 |
| *0.570 | 0.430 | 0.610 | ... |
| 0.496 | 0.504 | 0.643 | 0.96 |
| 0.394 | 0.606 | 0.681 | 0.95 |
| 0.298 | 0.702 | 0.701 | 0.95 |
| 0.200 | 0.800 | 0.670 | 0.95 |
| 0.100 | 0.900 | 0.610 | 0.96 |
| 0.031 | 0.969 | 0.461 | 0.97 |

### Benzylethyl Ether and Water.
(Bonner, 1910.)
Composition of Homogeneous Mixtures.

| Gms. $C_6H_5CH_2.O.C_2H_5$. | Gms. $H_2O$. | Gms. $C_2H_5OH$. | Sp. Gr. Sat. Sol. |
|---|---|---|---|
| 0.971 | 0.029 | 0.189 | 0.94 |
| 0.90 | 0.10 | 0.37 | 0.92 |
| 0.80 | 0.20 | 0.54 | 0.92 |
| 0.70 | 0.30 | 0.67 | 0.91 |
| *0.67 | 0.33 | 0.71 | ... |
| 0.60 | 0.40 | 0.78 | 0.91 |
| 0.50 | 0.50 | 0.87 | 0.91 |
| 0.40 | 0.60 | 0.93 | 0.92 |
| 0.30 | 0.70 | 0.96 | 0.92 |
| 0.198 | 0.802 | 0.952 | 0.92 |
| 0.10 | 0.90 | 0.86 | 0.93 |
| 0.08 | 0.92 | 0.793 | 0.94 |

## Miscibility of Ethyl Alcohol (see Note, p. 4 ) at 0° with Mixtures of:

### Methyl Aniline and Water. (Bonner, '10.)
Composition of Homogeneous Mixtures.

| Gms. $CH_3NHC_6H_5$. | Gms. $H_2O$. | Gms. $C_2H_5OH$. | Sp. Gr. Sat. Sol. |
|---|---|---|---|
| 0.959 | 0.041 | 0.218 | 0.96 |
| 0.90 | 0.10 | 0.37 | 0.95 |
| 0.795 | 0.205 | 0.555 | 0.93 |
| 0.70 | 0.30 | 0.68 | 0.93 |
| *0.66 | 0.34 | 0.72 | ... |
| 0.60 | 0.40 | 0.76 | 0.93 |
| 0.50 | 0.50 | 0.84 | 0.93 |
| 0.40 | 0.60 | 0.89 | 0.93 |
| 0.30 | 0.70 | 0.91 | 0.93 |
| 0.20 | 0.80 | 0.87 | 0.94 |
| 0.098 | 0.902 | 0.734 | 0.95 |
| 0.041 | 0.959 | 0.581 | 0.96 |

### Phenetol and Water. (Bonner, '10.)
Composition of Homogeneous Mixtures.

| Gms. $C_6H_5OC_2H_5$. | Gms. $H_2O$. | Gms. $C_2H_5OH$. | Sp. Gr. Sat. Sol. |
|---|---|---|---|
| 0.992 | 0.18 | 0.157 | 0.96 |
| *0.90 | 0.10 | 0.55 | ... |
| 0.897 | 0.103 | 0.554 | 0.93 |
| 0.798 | 0.202 | 0.916 | 0.90 |
| 0.70 | 0.30 | 1.18 | 0.90 |
| 0.60 | 0.40 | 1.39 | 0.89 |
| 0.495 | 0.505 | 1.518 | 0.89 |
| 0.399 | 0.601 | 1.560 | 0.89 |
| 0.30 | 0.70 | 1.54 | 0.90 |
| 0.198 | 0.802 | 1.449 | 0.91 |
| 0.10 | 0.90 | 1.21 | 0.92 |
| 0.082 | 0.918 | 1.156 | 0.93 |

## Reciprocal Solubility of Ethyl Alcohol, Toluene and Water.
(Ormandy and Craven, 1921.)

The determinations were made by the method outlined under heptane (p. 149·). An extensive series of determinations were made at seven different temperatures. These results have been plotted and the following table constructed from the curves.

| Wt. % $C_2H_5OH$ in Aq. Alcohol mixture used. | Gms. $C_6H_5CH_3$ per 100 gms. sat. solution at | | | | | | |
|---|---|---|---|---|---|---|---|
| | −30°. | −15°. | 0°. | +5°. | 15°. | 25°. | 30°. |
| 60..... | – | – | – | – | – | – | 8.0 |
| 65..... | 5.5 | 6.5 | 8.5 | 9.5 | 10.2 | (11.5) | 12.5 |
| 70..... | 8.6 | 10.5 | 12.7 | 14.0 | 15.6 | (17.5) | 19.5 |
| 75..... | 13.5 | 16.2 | 19.2 | 21.0 | 23.7 | (28.0) | 31.0 |
| 80..... | 20.7 | 25.0 | 30.5 | 33.5 | 38.5 | 46.0 | 49.5 |
| 85..... | 33.2 | 41.0 | 52.0 | 55.5 | 62.5 | 66.5 | 68.7 |
| 90..... | 62.5 | 71.0 | 77.0 | 79.5 | 82.0 | ? | 83.7 |
| 95..... | 92.5 | 94.5 | 94.5 | 95.0 | 93.7 | ? | 95.7 |

Data for the reciprocal solubility of ethyl alcohol, water and a mixture of 3 volumes of benzene and 1 volume of toluene at — 15°, 0°, + 15° and 30° are also given.

## Freezing-Points of Mixtures of 99.3 wt. per cent Alcohol and Toluene.

(Ormandy and Craven, 1921.)

| F. pt | Wt. % 99.3 Wt. % Alcohol in mixture. | F. pt. | Wt. % 99.3 Wt. % Alcohol in mixture. | F. pt | Wt. % 99.3 Wt. % Alcohol in mixture. |
|---|---|---|---|---|---|
| —30.0..... | 66.3 | —20.8..... | 39.8 | —5.8..... | 18.3 |
| —40.6..... | 59.7 | —18.3..... | 36.3 | —2.2..... | 12.6 |
| —28.2..... | 48.0 | —15.4..... | 32.6 | +1.1..... | 7.0 |
| —27.1..... | 46.6 | —12.3..... | 28.0 | 3.5..... | 2.7 |
| —24.0..... | 43.4 | — 8.8..... | 23.4 | | |

## Composition of the Conjugate Layers in the System Ethyl Alcohol, Toluene and Water.

(Tarassenkow and Pologlenzewa, 1932.)

| | Upper Layer | | | | Lower Layer | | | |
|---|---|---|---|---|---|---|---|---|
| t° | Gms. per 100 gms. homogeneous liquid | | | d. | Gms. per 100 gms. homogeneous liquid | | | d. |
| | $C_6H_5CH_3$ | $C_2H_5OH$ | $H_2O$ | | $C_6H_5CH_3$ | $C_6H_5OH$ | $H_2O$ | |
| 0 | 95.55 | 3.00 | 1.45 | — | 3.02 | 47.61 | 46.73 | — |
| " | 93.43 | 5.31 | 1.26 | — | 8.00 | 55.92 | 36.08 | — |
| " | 91.40 | 5.98 | 2.88 | 0.8738 | 15.44 | 55.86 | 28.70 | 0.8791 |
| " | 27.50 | 35.06 | 17.44 | 0.8667 | 88.14 | 9.37 | 2.43 | 0.8717 |
| 20 | 96.20 | 1.60 | 2.20 | 0.8707 | 0.40 | 31.37 | 68.23 | 0.9424 |
| " | 98.88 | 4.67 | 1.55 | 0.8588 | 3.44 | 46.56 | 50.00 | 0.9024 |
| " | 88.27 | 9.66 | 2.07 | 0.8553 | 18.10 | 53.37 | 28.53 | 0.8652 |
| " | 39.50 | 47.38 | 13.12 | 0.8505 | 75.24 | 21.45 | 3.31 | 0.8510 |
| 40 | 96.18 | 1.64 | 2.18 | 0.8420 | 0.54 | 30.24 | 69.20 | 0.9351 |
| " | 91.24 | 5.25 | 3.50 | 0.8394 | 3.23 | 45.52 | 51.24 | 0.9020 |
| " | 89.81 | 7.45 | 2.74 | 0.8380 | 5.98 | 47.32 | 46.20 | 0.8862 |
| " | 81.35 | 13.92 | 4.73 | 0.8338 | 20.65 | 51.39 | 27.46 | 0.8510 |
| " | 70.67 | 22.82 | 6.54 | 0.8328 | 36.98 | 47.00 | 16.02 | 0.8382 |
| " | 70.55 | 23.99 | 5.43 | 0.8330 | 36.13 | 45.81 | 18.06 | 0.8384 |

## Equilibrium in the System Ethyl Alcohol, Toluene and Water at 25°.

(Washburn, Beguin and Beckord, 1939.)

The binodal curve was determined by the titration method. The refractive indices of the homogeneous solutions were determined as well as those of the layers formed by mixing appropriate amounts of the liquids and from these results the tie lines were located.

| Gms. per 100 gms. homogeneous liquid | | | Gms. per 100 gms. homogeneous liquid | | |
|---|---|---|---|---|---|
| $C_2H_5CH_3$ | $C_2H_5OH$ | $H_2O$ | $C_6H_5CH_3$ | $C_2H_5OH$ | $H_2O$ |
| 89.84 | 9.36 | 0.81 | 29.52 | 52.89 | 17.59 |
| 81.13 | 16.74 | 2.13 | 19.96 | 56.42 | 23.63 |
| 70.46 | 25.29 | 4.25 | 12.94 | 56.66 | 30.39 |
| 60.61 | 32.66 | 6.73 | 6.37 | 53.04 | 40.59 |
| 49.26 | 40.83 | 9.91 | 3.72 | 48.89 | 47.39 |
| 39.40 | 47.37 | 13.23 | 1.75 | 42.48 | 55.76 |

MISCIBILITY OF ETHYL ALCOHOL (see Note p. 4 ) AT 0° WITH MIXTURES OF:

Pinene and Water. (Bonner, 1910.)

Composition of Homogeneous Mixtures.

| Gms. $C_{10}H_{16}$. | Gms. $H_2O$. | Gms. $C_2H_5OH$. | Sp. Gr. Sat. Sol. |
|---|---|---|---|
| 0.99 | 0.010 | 0.268 | 0.87 |
| *0.985 | 0.015 | 0.47 | ... |
| 0.897 | 0.103 | 1.595 | 0.85 |
| 0.795 | 0.205 | 2.268 | 0.84 |
| 0.70 | 0.30 | 2.67 | 0.84 |
| 0.60 | 0.40 | 2.94 | 0.85 |
| 0.493 | 0.507 | 3.135 | 0.85 |
| 0.393 | 0.607 | 3.126 | 0.86 |
| 0.293 | 0.707 | 3.038 | 0.86 |
| 0.194 | 0.806 | 2.799 | 0.87 |
| 0.094 | 0.906 | 2.331 | 0.89 |
| 0.035 | 0.965 | 1.639 | 0.91 |

Propyl Bromide and Water. (Bonner, 1910.)

Composition of Homogeneous Mixtures.

| Gms. $CH_3.CH_2.CH_2Br$. | Gms. $H_2O$. | Gms. $C_2H_5OH$. | Sp. Gr. Sat. Sol. |
|---|---|---|---|
| 0.975 | 0.025 | 0.190 | 1.26 |
| *0.92 | 0.08 | 0.42 | ... |
| 0.90 | 0.10 | 0.50 | 1.12 |
| 0.80 | 0.20 | 0.72 | 1.06 |
| 0.70 | 0.30 | 0.88 | 1.02 |
| 0.60 | 0.40 | 1.01 | 0.99 |
| 0.50 | 0.50 | 1.10 | 0.98 |
| 0.40 | 0.60 | *1.15 | 0.96 |
| 0.30 | 0.70 | 1.14 | 0.95 |
| 0.204 | 0.796 | 1.12 | 0.94 |
| 0.096 | 0.904 | 1.02 | 0.94 |
| 0.027 | 0.973 | 0.687 | 0.95 |

MISCIBILITY OF ETHYL ALCOHOL (see Note p. 4 ) AT 0° WITH MIXTURES OF:

Toluene and Water. (Bonner, 1910.)

Composition of Homogeneous Mixtures.

| Gms. $C_6H_5CH_3$. | Gms. $H_2O$. | Gms. $C_2H_5OH$. | Sp. Gr. Sat. Sol. |
|---|---|---|---|
| 0.948 | 0.052 | 0.388 | 0.87 |
| 0.90 | 0.10 | 0.61 | 0.86 |
| 0.80 | 0.20 | 0.95 | 0.86 |
| 0.70 | 0.30 | 1.21 | 0.86 |
| 0.60 | 0.40 | 1.41 | 0.86 |
| 0.50 | 0.50 | 1.53 | 0.87 |
| 0.40 | 0.60 | 1.59 | 0.87 |
| 0.30 | 0.70 | 1.56 | 0.88 |
| 0.20 | 0.80 | 1.44 | 0.89 |
| 0.10 | 0.90 | 1.23 | 0.91 |
| 0.028 | 0.972 | 0.817 | 0.94 |

*o* Toluidine and Water. (Bonner, 1910.)

Composition of Homogeneous Mixtures.

| Gms. $CH_3.C_6H_4.NH_2$. | Gms. $H_2O$. | Gms. $C_2H_5OH$. | Sp. Gr. Sat. Sol. |
|---|---|---|---|
| 0.954 | 0.046 | 0.025 | 1.01 |
| 0.90 | 0.10 | 0.21 | 0.93 |
| 0.80 | 0.20 | 0.32 | 0.97 |
| 0.70 | 0.30 | 0.41 | 0.96 |
| 0.60 | 0.40 | 0.455 | 0.96 |
| 0.50 | 0.50 | 0.48 | 0.96 |
| 0.40 | 0.60 | 0.50 | 0.96 |
| 0.30 | 0.70 | 0.50 | 0.96 |
| 0.20 | 0.80 | 0.49 | 0.96 |
| 0.098 | 0.902 | 0.462 | 0.98 |
| 0.027 | 0.973 | 0.262 | ... |

MISCIBILITY OF ETHYL ALCOHOL (see Note p. 4 ) AT 0° WITH MIXTURES OF:

Bromotoluene (b. pt. 182–3) and Water.

(Bonner, 1910.)

Composition of Homogeneous Mixtures.

| Gms. $BrC_6H_4.CH_3$. | Gms. $H_2O$. | Gms. $C_2H_5OH$. | Sp. Gr. Sat. Sol. |
|---|---|---|---|
| 0.98 | 0.02 | 0.33 | ... |
| 0.951 | 0.049 | 0.522 | 1.09 |
| 0.90 | 0.10 | 0.87 | 1.06 |
| 0.80 | 0.20 | 1.28 | 0.97 |
| 0.70 | 0.30 | 1.54 | 0.94 |
| 0.60 | 0.40 | 1.71 | 0.93 |
| 0.50 | 0.50 | 1.81 | 0.92 |
| 0.40 | 0.60 | 1.89 | 0.91 |
| 0.30 | 0.70 | 1.89 | 0.90 |
| 0.20 | 0.80 | 1.78 | 0.90 |
| 0.10 | 0.90 | 1.533 | 0.91 |
| 0.033 | 0.967 | 1.307 | 0.92 |

*p* Nitrotoluene and Water.

(Bonner, 1910.)

Composition of Homogeneous Mixtures.

| Gms. $NO_2.C_6H_4.CH_3$. | Gms. $H_2O$. | Gms. $C_2H_5OH$. | Sp. Gr. Sat. Sol. |
|---|---|---|---|
| 0.978 | 0.022 | 0.253 | 1.08 |
| *0.95 | 0.05 | 0.50 | ... |
| 0.90 | 0.10 | 0.84 | 0.97 |
| 0.80 | 0.20 | 1.29 | 0.96 |
| 0.70 | 0.30 | 1.57 | 0.92 |
| 0.60 | 0.40 | 1.73 | 0.91 |
| 0.506 | 0.494 | 1.782 | 0.91 |
| 0.398 | 0.602 | 1.868 | 0.91 |
| 0.294 | 0.706 | 1.816 | 0.91 |
| 0.20 | 0.80 | 1.63 | 0.91 |
| 0.10 | 0.90 | 1.30 | 0.92 |
| 0.056 | 0.944 | 1.105 | 0.93 |

RECIPROCAL SOLUBILITY OF ETHYL ALCOHOL, XYLENE AND WATER AT —30°, 0° AND +30°. (Ormandy and Craven, 1921.)

The xylene was a commercial sample having $d_{\frac{15}{15}} = 0.8665$ and b. pt. 138°-148°. The determinations were made by the method outlined under heptane (p. 149).

| Results at —30°. | | Results at 0°. | | Results at +30°. | |
|---|---|---|---|---|---|
| Wt % $C_2H_5OH$ in aq. alcohol mixture used. | Gms. xylene per 100 gms. sat. sol. | Wt % $C_2H_5OH$ in aq. alcohol mixture used. | Gms. xylene per 100 gms. sat. sol. | Wt % $C_2H_5OH$ in aq. alcohol mixture used. | Gms. xylene per 100 gms. sat. sol. |
| 78.65 | 11.59 | 72.35 | 9.47 | 66.55 | 8.67 |
| 80.60 | 13.92 | 74.24 | 11.25 | 69.40 | 11.45 |
| 82.96 | 17.40 | 76 97 | 14.39 | 73.00 | 15.77 |
| 85.46 | 22.20 | 80.33 | 19.57 | 77.24 | 23.12 |
| 87.14 | 26.73 | 84.05 | 28.02 | 81.30 | 34.70 |
| 90.90 | 41.89 | 87.24 | 40.92 | 84.68 | 52.01 |
| 92.66 | 53.49 | 90.24 | 64.09 | 92.20 | 82.67 |
| 94.11 | 70.77 | 93.90 | 83.18 | 91.90 | 92.22 |
| 95.66 | 83.87 | 93.70 | 92.67 | | |
| 96.29 | 92.87 | | | | |

FREEZING-POINTS OF MIXTURES OF 99.3 WT. % ETHYL ALCOHOL AND XYLENE. (Ormandy and Craven, 1921.)

The xylene was a mixture of *o*, *m* and *p* xylene.

| t° of f. pt. | —30°.0. | —24°.7. | —19°.8. | —15°.9. | —10°.9. | —1°.0. |
|---|---|---|---|---|---|---|
| Wt. % of 99.3 wt. % alcohol in mixture. | 56.1 | 49.6 | 43.1 | 35.8 | 29.7 | 11.9 |

RECIPROCAL SOLUBILITY OF ETHYL ALCOHOL, PHENYL ETHER AND WATER AT 30°. (Perrakis, 1925.)

The amount of water required to produce clouding in various mixtures of ethyl alcohol and phenyl ether, $(C_6H_5)_2O$, was determined by a titration method.

| Wt % $C_2H_5OH$ in alc. phenyl ether mixture. | Gms. $H_2O$ to cause clouding of 100 cc. of mixture. | Wt % $C_2H_5OH$ in alc. phenyl ether mixture. | Gms. $H_2O$ to cause clouding of 100 cc. of mixture. |
|---|---|---|---|
| 13.18 | 0.6206 | 36.68 | 2.2654 |
| 22.01 | 1.1151 | 40.08 | 2.5709 |
| 28.41 | .5360 | 43.16 | 2.8450 |
| 32.76 | 1.9230 | 50.57 | 3.5400 |

MISCIBILITY OF ETHYL ALCOHOL (see Note p. 4) AT 0° WITH MIXTURES OF:

*o* Xylene and Water. (Bonner, 1910.)

| Composition of Homogeneous Mixtures. | | | |
|---|---|---|---|
| Gms. *o* $C_6H_4(CH_3)_2$. | Gms. $H_2O$. | Gms. $C_2H_5OH$. | Sp. Gr. Sat. Sol. |
| 0.971 | 0.029 | 0.352 | 0.89 |
| *0.96 | 0.04 | 0.53 | ... |
| 0.90 | 0.10 | 0.93 | 0.87 |
| 0.786 | 0.21 | 1.32 | 0.87 |
| 0.70 | 0.30 | 1.53 | 0.87 |
| 0.60 | 0.40 | 1.72 | 0.87 |
| 0.50 | 0.50 | 1.87 | 0.87 |
| 0.40 | 0.60 | 1.96 | 0.88 |
| 0.30 | 0.70 | 1.94 | 0.88 |
| 0.20 | 0.80 | 1.81 | 0.89 |
| 0.031 | 0.969 | 1.19 | 0.93 |

*m* Xylene and Water. (Bonner, 1910.)

| Composition of Homogeneous Mixtures. | | | |
|---|---|---|---|
| Gms. *m* $C_6H_4(CH_3)_2$. | Gms. $H_2O$. | Gms. $C_2H_5OH$. | Sp. Gr. Sat. Sol. |
| 0.967 | 0.033 | 0.388 | 0.88 |
| 0.90 | 0.10 | 0.81 | 0.87 |
| 0.80 | 0.20 | 1.30 | 0.85 |
| 0.70 | 0.30 | 1.61 | 0.86 |
| 0.60 | 0.40 | 1.77 | 0.86 |
| 0.50 | 0.50 | 1.90 | 0.87 |
| 0.40 | 0.60 | 1.98 | 0.87 |
| 0.30 | 0.70 | 2.01 | 0.88 |
| 0.20 | 0.80 | 1.87 | 0.89 |
| 0.10 | 0.90 | 1.53 | 0.90 |
| 0.023 | 0.977 | 1.168 | 0.92 |

Additional data for the system ethyl alcohol, *m* xylene, water at 0°, 19°, 41°, 63° and 100° are given by Holt and Bell, 1914.

*p* XYLENE AND WATER. (Bonner, 1910.)

| Composition of Homogeneous Mixtures. | | | |
|---|---|---|---|
| Gms. *p* $C_6H_4(CH_3)_2$. | Gms. $H_2O$. | Gms. $C_2H_5OH$. | Sp. Gr. Sat. Sol. |
| 0.966. | 0.034 | 0.306 | 0.84 |
| *0.92 | 0.08 | 0.57 | ... |
| 0.90 | 0.10 | 0.65 | 0.85 |
| 0.80 | 0.20 | 1.05 | 0.85 |
| 0.70 | 0.30 | 1.35 | 0.85 |
| 0.60 | 0.40 | 1.56 | 0.85 |

| Composition of Homogeneous Mixtures. | | | |
|---|---|---|---|
| Gms. *p* $C_6H_4(CH_3)_2$. | Gms. $H_2O$. | Gms. $C_2H_5OH$. | Sp. Gr. Sat. Sol. |
| 0.50 | 0.50 | 1.68 | 0.86 |
| 0.40 | 0.60 | 1.77 | 0.86 |
| 0.292 | 0.702 | 1.743 | 0.87 |
| 0.193 | 0.807 | 1.625 | 0.88 |
| 0.100 | 0.90 | 1.39 | 0.89 |
| 0.015 | 0.985 | 0.863 | 0.93 |

## Reciprocal Solubility of Ethyl Alcohol, Pentane and Water at —30°, 0° and +15°.

(Ormandy and Craven, 1922.)

The determinations were made by the method outlined under heptane (p. 147.).

| Results at —30°. | | Results at 0°. | | Results at +15°. | |
|---|---|---|---|---|---|
| Wt. % $C_2H_5OH$ in Aq. Alcohol mixture used. | Wt. % Pentane in sat. sol. | Wt. % $C_2H_5OH$ in Aq. Alcohol mixture used. | Wt. % Pentane in sat. sol. | Wt. % $C_2H_5OH$ in Aq. Alcohol mixture used. | Wt. % Pentane in sat. sol. |
| 76.54..... | 7.90 | 79.55..... | 15.89 | 74.56..... | 13.38 |
| 82.60..... | 14.10 | 84.26..... | 25.51 | 78.22..... | 18.35 |
| 85.25..... | 18.82 | 86.05..... | 32.24 | 84.63..... | 27.67 |
| 88.53..... | 28.48 | 87.98..... | 42.66 | 85.45..... | 37.54 |
| 90.35..... | 38.11 | 89.29..... | 53.66 | 86.91..... | 47.05 |
| 91.42..... | 45.66 | | | 88.08..... | 58.55 |
| 92.16..... | 58.89 | | | 89.04..... | 68.23 |
| | | | | 90.27..... | 77.39 |

## Freezing-Points of Mixtures of 92.0 wt. per cent Alcohol and :

(Ormandy and Craven, 1922.)

| Pentane. | | Isopentane. | |
|---|---|---|---|
| F. pt. | Wt. % Pentane. | F. pt. | Wt. % Isopentane. |
| —31.0..... | 26.70 | —28.5..... | 31.59 |
| —22.5..... | 30.41 | —14.2..... | 35.21 |
| —16.0..... | 35.80 | — 5.0..... | 40.69 |
| — 5.0..... | 39.47 | + 4.3..... | 48.07 |
| + 4.9..... | 45.62 | 12.5..... | 57.42 |
| 14.0..... | 55.91 | 21.3..... | 67.18 |
| 21.0..... | 63.68 | | |

Similar data are also given for the freezing-points of 92.0 wt. % alcohol containing different amounts of a 1 : 1 and a 3 : 1 mixture of pentane and benzene.

## Reciprocal Solubility of Ethyl Alcohol, Hexane and Water at —30° and +30°. (Ormandy and Craven, 1922.)

Three samples of hexane, obtained from different sources, were used. These had densities and boiling-points which differed from published data, and were, therefore, of unknown purity. Reciprocal solubility determinations were made as described under heptane (following page). The original determinations of the authors, when plotted on cross section paper, give average curves from which the following values were read.

| Wt. % $C_2H_5OH$ in aq. Alcohol Mixture used. | Gms. Hexane per 100 gms. sat. sol. at | |
|---|---|---|
| | —30°. | +30°. |
| 75.0 | — | 8.0 |
| 80.0 | — | 12.5 |
| 84.0 | 8.0 | 19.0 |
| 86.0 | 10.0 | 23.5 |
| 88.0 | 12.5 | 30.0 |
| 90.0 | 16.0 | 41.0 |

| Wt. % $C_2H_5OH$ in aq. Alcohol Mixture used. | Gms. Hexane per 100 gms. sat. sol. at | |
|---|---|---|
| | —30°. | +30°. |
| 92.0 | 21.0 | 60.0 |
| 94.0 | 29.5 | 81.0 |
| 95.0 | 36.0 | 92.0 |
| 96.0 | 47.0 | — |
| 97.0 | 68.5 | — |
| 98.0 | 92.0 | — |

### Freezing-Points of Mixtures of 92.0 wt. per cent Alcohol and Various Samples of Hexane. (Ormandy and Craven, 1922.)

The samples of hexane were the same as used for the preceding determinations.

| Results with: Sample I. | | Results with: Sample II. | | Results with: Sample III. | |
|---|---|---|---|---|---|
| F. pt. | Wt. % Hexane. | F. pt. | Wt. % Hexane. | F. pt. | Wt. % Hexane. |
| —31.1 | 21.97 | —31.4 | 21.81 | —29.9 | 21.98 |
| —26.2 | 23.18 | —21.8 | 24.85 | —21.0 | 24.71 |
| — 9.5 | 29.58 | — 8.2 | 30.12 | —11.5 | 28.11 |
| + 7.6 | 39.16 | + 7.8 | 39.48 | + 0.3 | 33.70 |
| 20.6 | 53.71 | 20.3 | 52.89 | 10.7 | 40.59 |
| 30.5 | 66.57 | 30.7 | 66.63 | 20.8 | 51.32 |
| | | | | 30.8 | 64.88 |

Data are also given for the freezing-points of 92.0 wt. % alcohol containing different amounts of a 1 : 1 and a 3 : 1 mixture of hexane and benzene.

### Miscibility of Ethyl Alcohol (see Note, p. 4 ) at 0° with Mixtures of:

Heptane and Water. (Bonner, 1910.)

| Composition of Homogeneous Mixtures. | | | |
|---|---|---|---|
| Gms. Heptane.* | Gms. $H_2O$. | Gms. $C_2H_5OH$. | Sp. Gr. Sat. Sol. |
| 0.962 | 0.038 | 0.704 | 0.79 |
| 0.90 | 0.10 | 1.44 | 0.80 |
| 0.798 | 0.202 | 2.375 | 0.82 |
| 0.70 | 0.30 | 2.82 | 0.81 |
| 0.60 | 0.40 | 3.06 | 0.82 |
| 0.50 | 0.50 | 3.16 | 0.83 |
| 0.40 | 0.60 | 3.17 | 0.84 |
| 0.30 | 0.70 | 3.10 | 0.85 |
| 0.196 | 0.804 | 2.96 | 0.87 |
| 0.093 | 0.907 | 2.305 | 0.88 |

Hexane and Water. (Bonner, 1910.)

| Composition of Homogeneous Mixtures. | | | |
|---|---|---|---|
| Gms. Hexane.* | Gms. $H_2O$. | Gms. $C_2H_5OH$. | Sp. Gr. Sat. Sol. |
| 0.97 | 0.03 | 0.59 | ... |
| 0.90 | 0.10 | 1.30 | 0.77 |
| 0.80 | 0.20 | 2.04 | 0.79 |
| 0.70 | 0.30 | 2.45 | 0.81 |
| 0.60 | 0.40 | 2.73 | 0.82 |
| 0.50 | 0.50 | 2.93 | 0.83 |
| 0.40 | 0.60 | 3.00 | 0.83 |
| 0.20 | 0.80 | 2.75 | 0.85 |
| 0.10 | 0.90 | 2.23 | 0.86 |
| 0.014 | 0.986 | 1.056 | ... |

* Kahlbaum's Heptane and Hexane "aus Petroleum" were used.

### Reciprocal Solubility of Ethyl Alcohol, Heptane and Water. (Ormandy and Craven, 1922.)

The heptane was purified by acid washing and fractionation. The $d_{\frac{15}{15}} = 0.6887$ and the b. pt. was 98°.3-98°.4 (760 mm.). The aniline point was 71°. The determinations were made by adding to a given volume of the hydrocarbon a mixture of alcohol and water untill clouding appeared. Two concentrations of alcohol contained in two pipets were used and the clouding produced and discharged alternately. The weights of each constituent were calculated from the specific gravity of each and the results reported on the weight per cent basis.

| Results at —30°. | | Results at 0°. | | Results at +30°. | |
|---|---|---|---|---|---|
| Wt. % $C_2H_5OH$ in aq.-alc. mixture used. | Wt. % heptane in sat. sol. | Wt. % $C_2H_5OH$ in aq.-alc. mixture used. | Wt. % heptane in sat. sol. | Wt. % $C_2H_5OH$ in aq.-alc. mixture used. | Wt. % heptane in sat. sol. |
| 98.23 | 90.97 | 98.30 | 90.59 | 98.17 | 91.18 |
| 98.51 | 81.14 | 97.92 | 80.65 | 95.82 | 80.15 |
| 98.25 | 69.37 | 97.98 | 69.29 | 95.35 | 69.42 |
| 98.18 | 59.19 | 96.91 | 58.78 | 94.26 | 58.84 |
| 97.99 | 49.52 | 96.41 | 48.68 | 93.47 | 49.44 |
| 97.06 | 39.31 | 95.72 | 38.61 | 92.78 | 39.00 |
| 96.28 | 29.54 | 94.36 | 29.57 | 91.16 | 29.28 |
| 94.62 | 20.56 | 91.98 | 19.75 | 88.61 | 19.96 |
| 92.93 | 15.24 | 90.27 | 15.42 | 85.94 | 14.25 |
| 89.37 | 8.92 | 85.35 | 8.56 | 80.94 | 8.39 |

Similar determinations made with unpurified heptane gave results close to the above. It is suggested that the higher values obtained by Bonner, 1910, are probably due to the presence of a small amount of aromatic hydrocarbon in his heptane.

### Freezing-Points of Mixtures of 92.0 wt. per cent Alcohol and Various Samples of Heptane. (Ormandy and Craven, 1922.)

Three samples of heptane, obtained from different sources, were used. The densities and boiling-point fractionation figures of the samples show considerable differences from published data. The samples were, therefore, of unknown purity.

| Results with: Sample I. | | Results with: Sample II. | | Results with: Sample III. | |
|---|---|---|---|---|---|
| F. pt. | Wt. % Heptane. | F. pt. | Wt. % Heptane. | F. pt. | Wt. % Heptane. |
| —30.5 | 13.27 | —30.3 | 13.66 | —30.3 | 16.22 |
| —22.2 | 14.91 | —23.1 | 15.17 | —20.5 | 18.48 |
| —14.6 | 16.69 | —11.0 | 18.04 | —10.9 | 21.23 |
| + 0.4 | 20.77 | + 3.2 | 22.36 | + 0.9 | 25.18 |
| 21.9 | 29.93 | 19.6 | 29.38 | 10.7 | 29.35 |
| 32.0 | 37.06 | 29.9 | 36.43 | 20.7 | 35.02 |
| | | | | 30.9 | 44.40 |

Data are also given for the freezing-points of 92.0 wt. % alcohol containing different amounts of various mixtures of heptane and benzene.

### Equilibrium in the System Ethyl Alcohol, Hexane and Water.

(Tarassenkow and Paulsen, 1937.)

Results at 0°

| Gms. per 100 gms. homogeneous mixture | | |
|---|---|---|
| $C_2H_5OH$ | $C_6H_{14}$ | $H_2O$ |
| 6.53 | 92.70 | 0.77 |
| 44.30 | 54.10 | 1.60 |
| 53.32 | 45.39 | 1.29 |
| 63.34 | 35.18 | 1.48 |
| 74.01 | 21.67 | 4.32 |
| 79.22 | 11.86 | 8.92 |
| 78.74 | 7.96 | 13.30 |
| 79.08 | 7.32 | 13.60 |
| 76.82 | 4.00 | 19.18 |
| 69.85 | 2.13 | 28.02 |
| 69.43 | 1.57 | 29.00 |
| 60.04 | 0.94 | 39.02 |
| 43.12 | 0.42 | 56.46 |

Results at 25°

| Gms. per 100 gms. homogeneous mixture | | |
|---|---|---|
| $C_2H_5OH$ | $C_6H_{14}$ | $H_2O$ |
| 3.10 | 95.92 | 0.98 |
| 18.52 | 79.90 | 1.51 |
| 36.28 | 61.64 | 2.08 |
| 37.82 | 59.70 | 2.48 |
| 51.94 | 45.91 | 2.15 |
| 68.03 | 28.11 | 3.86 |
| 73.84 | 17.61 | 8.55 |
| 74.73 | 12.93 | 12.34 |
| 73.52 | 8.00 | 18.48 |
| 67.49 | 3.61 | 28.90 |
| 53.81 | 1.86 | 44.38 |
| 36.68 | 1.21 | 62.11 |

The composition of the following conjugate layers at 25° was also determined.

| Gms. per 100 gms. upper layer | | |
|---|---|---|
| $C_2H_5OH$ | $C_6H_{14}$ | $H_2O$ |
| 0.08 | 99.31 | 0.61 |
| 1.75 | 97.71 | 0.54 |

| Gms. per 100 gms. lower layer | | |
|---|---|---|
| $C_2H_5OH$ | $C_6H_{14}$ | $H_2O$ |
| 37.67 | 0.23 | 62.10 |
| 56.92 | 2.91 | 40.47 |

## Equilibrium in the System Ethyl Alcohol, Cyclohexane and Water.

(Tarassenkow and Paulsen, 1937.)

Results at 0°

| Gms. per 100 gms. homogeneous mixture | | |
|---|---|---|
| $C_2H_5OH$ | $C_6H_{12}$ | $H_2O$ |
| 14.49 | 84.88 | 0.69 |
| 30.62 | 67.62 | 1.86 |
| 50.03 | 46.99 | 2.98 |
| 62.14 | 32.50 | 5.36 |
| 71.98 | 14.60 | 13.42 |
| 71.84 | 11.71 | 16.45 |
| 68.63 | 4.65 | 26.72 |
| 54.41 | 1.22 | 44.37 |

Results at 25°

| Gms. per 100 gms. homogeneous mixture | | |
|---|---|---|
| $C_2H_5OH$ | $C_6H_{12}$ | $H_2O$ |
| 33.10 | 64.80 | 2.10 |
| 48.18 | 47.54 | 4.28 |
| 55.24 | 39.45 | 5.31 |
| 59.11 | 34.97 | 5.92 |
| 64.91 | 26.14 | 8.95 |
| 69.20 | 16.27 | 14.53 |
| 68.45 | 8.85 | 22.65 |
| 60.07 | 2.17 | 37.76 |

The composition of the following conjugate layers at 25° was also determined.

| Gms. per 100 gms. upper layer | | |
|---|---|---|
| $C_2H_5OH$ | $C_6H_{12}$ | $H_2O$ |
| 0.61 | 99.07 | 0.32 |
| 1.56 | 98.09 | 0.35 |
| 9.89 | 88.96 | 1.15 |

| Gms. per 100 gms. lower layer | | |
|---|---|---|
| $C_2H_5OH$ | $C_6H_{14}$ | $H_2O$ |
| 45.98 | 1.19 | 52.83 |
| 54.98 | 1.35 | 43.67 |
| 66.24 | 22.19 | 11.57 |

## Equilibrium in the System Ethyl Alcohol, Cyclohexane and Water at 25°.

(Vold and Washburn, 1932.)

The binodal curve was determined by the titration method. The refractive indices of these and of the two layers obtained with appropriate amounts of the three liquids gave results from which the distribution of alcohol between water and cyclohexane was calculated. Results for the freezing-points of mixtures of ethyl alcohol and cyclohexane are also given.

| Gms. per 100 gms. homogeneous mixture | | |
|---|---|---|
| $C_2H_5OH$ | $C_6H_{12}$ | $H_2O$ |
| 7.63 | 0.32 | 92.05 |
| 20.05 | 0.59 | 79.36 |
| 41.06 | 0.08 | 58.86 |
| 43.24 | 0.54 | 56.22 |
| 50.38 | 0.81 | 48.81 |
| 53.85 | 1.36 | 44.79 |
| 61.63 | 3.09 | 35.28 |
| 66.99 | 6.98 | 26.03 |

| Gms. per 100 gms. homogeneous mixture | | |
|---|---|---|
| $C_2H_5OH$ | $C_6H_{12}$ | $H_2O$ |
| 68.47 | 8.84 | 22.69 |
| 69.31 | 13.88 | 16.81 |
| 67.89 | 20.38 | 11.73 |
| 65.41 | 25.98 | 8.61 |
| 61.59 | 30.63 | 7.78 |
| 48.17 | 47.54 | 4.29 |
| 33.14 | 64.79 | 2.07 |
| 16.70 | 82.41 | 0.89 |

The coefficient of distribution of ethyl alcohol between olive oil and water is 0.026 at 3° and 0.047 at 30°. (Meyer, 1901; 1909.)

100 gms. cottonseed oil (0.922 Sp. Gr.) dissolve 22.9 gms. ethyl alcohol at 25°.

100 gms. ethyl alcohol dissolve 11.75 gms. cottonseed oil at 25°. (Wroth and Reid, '16.)

DISTRIBUTION OF ETHYL ALCOHOL BETWEEN COTTONSEED OIL AND WATER AT 25°. (Wroth and Reid, 1916.)

| Gms. $C_2H_5OH$ per 100 cc. | | Ratio. |
|---|---|---|
| Oil Layer. | $H_2O$ Layer. | |
| 0.2083 | 6.147 | 29.5 |
| 0.2251 | 6.738 | 29.9 |
| 0.2515 | 6.835 | 27.1 |
| 0.2783 | 6.876 | 24.7 |
| 0.3017 | 8.682 | 28.7 |

Data for the reciprocal solubility of ethyl alcohol and turpentine are given by Vèzes and Mouline, 1904, 1905–06.

Data for the system ethyl alcohol, water, petroleum are given by Rodt (1916).

RECIPROCAL SOLUBILITY OF ETHYL ALCOHOL, GASOLINE AND WATER AT 5° AND AT 20°.

(Gay and Massol, 1925; Perrakis and Massol, 1924.)

A titration method was used. Various weighed mixtures of alcohol and gasoline were titrated with water to appearance of clouding.. Above 75 per cent of alcohol it was necessary to titrate mixtures of alcohol and water with gasoline. The composition of the mixture was determined in all cases by weighing. The gasoline had a $d_{\frac{20}{4}}$ of 0.747. On distilling 200 cc. the first 10 cc. came over at 60-69° and the last 10 cc. at 215-236°. A diagram of the distillation curve shows a somewhat wavy line between these temperatures.

Isotherm at 5°.

| Gms. per 100 gms. cloudy mixture. | |
|---|---|
| $C_2H_5OH$. | Gasoline. |
| 17.485 | 82.320 |
| 29.800 | 69.700 |
| 36.150 | 62.970 |
| 55.880 | 42.490 |
| 77.880 | 13.930 |
| 78.880 | 8.860 |
| 76.725 | 3.485 |
| 69.215 | 0.890 |
| 63.570 | 0.570 |
| 57.907 | 0.333 |
| 54.151 | 0.117 |

Isotherm at 20°.

| Gms. per 100 gms. cloudy mixture. | |
|---|---|
| $C_2H_5OH$. | Gasoline. |
| 3.210 | 96.725 |
| 11.390 | 88.400 |
| 24.060 | 75.360 |
| 26.025 | 73.070 |
| 54.635 | 42.500 |
| 67.275 | 27.750 |
| 73.555 | 17.910 |
| 76.655 | 10.155 |
| 74.310 | 4.700 |

| Gms. per 100 gms cloudy mixture. | |
|---|---|
| $C_2H_5OH$. | Gasoline. |
| 73.260 | 3.650 |
| 64.170 | 0.907 |
| 55.510 | 0.281 |
| 46.530 | 0.112 |
| 44.820 | 0.089 |
| 39.759 | 0.053 |
| 34.559 | 0.023 |
| 31.760 | 0.0105 |
| 24.299 | 0.0036 |

The authors also discuss the effect of salts upon the dehydration of alcohol. It was shown that ammonium sulfate and hyposulfite are poor dehydrating agents and potassium fluoride and carbonate are good dehydrating agents. They give results showing the composition of the upper layers in contact with sat. solutions of $K_2CO_3$. Much more complete data for the system alcohol + gasoline + water + $K_2CO_3$ at 20° are given by Gay, Mion and Servigne, 1924. These authors give numerical data and diagrams for the composition of each of the three layers which separate in this system

## Reciprocal Solubility of Ethyl Alcohol, Gasoline and Water.

(Bridgeman and Querfeld, 1933.)

The temperatures were determined at which a second phase separated on slowly cooling accurately prepared mixtures of gasoline (from different sources) and ethyl alcohol containing from 1 to 8 volume percent $H_2O$. Of the various gasoline samples the following two tables contain respectively the results for the one having the highest and the lowest critical solution temperatures.

### Results for sample No. 1

(Pennsylvania Gasoline of d = 0.738, having a volatility such that 10% distills up to 76°, 50% up to 135° and 90% up to 199°)

| Vol. % $H_2O$ in $C_2H_5OH$ | Temperatures of separation in mixtures containing: | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 Vol. % Gasoline |
| 1.11 | — | — | -61.0 | -46.4 | -37.4 | -33.4 | -31.0 | -28.3 | -26.4 |
| 2.13 | — | -60.0 | -36.8 | -24.0 | -15.1 | -10.3 | - 7.4 | - 2.5 | — |
| 3.14 | — | -45.0 | -18.0 | - 4.1 | 3.7 | 7.7 | 11.3 | 16.6 | 22.3 |
| 4.14 | -60.6 | -26.2 | - 3.2 | 11.5 | 18.7 | 22.4 | 26.4 | 33.1 | 39.4 |
| 5.18 | -54.7 | -12.7 | 11.3 | 24.3 | 30.8 | 34.4 | 39.5 | 47.7 | 52.9 |
| 6.20 | -43.2 | 0.3 | 22.5 | 35.3 | 41.6 | 45.7 | 51.6 | — | — |
| 7.24 | -30.2 | 12.6 | 33.7 | 45.0 | — | — | — | — | — |
| 8.24 | -19.3 | 23.2 | 43.2 | — | — | — | — | — | — |

### Results for Sample No. 7

(100% Cracked gasoline of d = 0.754, having a volatility such that 10% distills up to 54°, 50% up to 126° and 90% up to 188°)

| Vol. % $H_2O$ in $C_2H_5OH$ | Temperature of separation in mixtures containing: | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 Vol. % Gasoline |
| 1.13 | — | — | — | — | — | — | — | — | -53.1 |
| 2.14 | — | — | — | — | -49.8 | -44.8 | -40.1 | -30.9 | -19.9 |
| 3.18 | — | — | -59.9 | -40.0 | -26.8 | -19.3 | -15.9 | - 9.3 | 2.8 |
| 4.17 | — | — | -38.8 | -21.6 | -10.9 | - 4.6 | 0.7 | 9.6 | 24.5 |
| 5.19 | — | -50.2 | -23.7 | - 6.5 | 3.5 | 8.6 | 14.8 | 24.4 | 42.6 |
| 6.20 | — | -37.0 | - 9.1 | 6.2 | 14.7 | 20.2 | 27.0 | 39.0 | — |
| 7.22 | — | -23.6 | 4.0 | 18.0 | 25.8 | 32.0 | 39.4 | 51.4 | — |
| 8.29 | -58.1 | -11.6 | 14.5 | 27.4 | 35.5 | 41.1 | 50.5 | — | — |

The authors also present data showing the relation between volatility of a gasoline and its miscibility with ethyl alcohol containing water. The more volatile samples were found to be more miscible in that they gave mixtures having lower critical solution temperatures than similar mixtures with less volatile gasoline. Straight run gasolines of equal volatility show little difference in their miscibility temperatures with ethyl alcohol-water mixtures. Cracked gasolines may, however, show much lower critical solution temperatures than straight run products of the same volatility.

### Reciprocal Solubility of Ethyl Alcohol and Gasoline in Presence of a Third Solvent. (Rothen and Boutier, 1923.)

The alcohol had $d_{15} = 0.812$, The gasoline was an American product of $d_{15} = 0.723$. The titration method was employed. The figures in the table below show the cubic centimeters of the third solvent (A) which must be added to 100 cc. of the following volume per cent mixtures of alcohol and gasoline to obtain a homogeneous solu tion at 0° and 15°.

| | 10% Alcohol. | | 20% Alcohol. | | 30% Alcohol. | | 40% Alcohol. | | 50% Alcohol. | |
|---|---|---|---|---|---|---|---|---|---|---|
| Third solvent (A). | 0°. | −15°. | 0°. | −15°. | 0°. | −15°. | 0°. | −15°. | 0°. | −15°. |
| Benzene | * | * | * | * | 23.0 | * | 13.0 | 24.0 | 11.0 | 18.0 |
| Ether | – | – | 11.8 | 16.3 | 7.9 | 13.2 | 6.0 | 10.6 | 4.2 | 8.8 |
| Acetone | 19.0 | 36.0 | 18.0 | 50.0 | 18.0 | 56.0 | 15.0 | 43.0 | 12.0 | 35.0 |
| Iso propyl alcohol | 6.3 | 10.4 | 7.5 | 14.8 | 8.4 | 17.0 | 8.6 | 14.5 | 6.2 | 13.0 |
| Iso butyl » | – | – | – | – | 7.5 | 12.0 | – | – | 6.0 | 12.0 |
| Normal butyl alcohol | 4.1 | 5.3 | 4.6 | 6.7 | 4.7 | 7.5 | 4.5 | 5.8 | 3.8 | 7.5 |
| Amyl alcohol | 4.1 | 5.3 | 4.4 | 6.3 | 4.6 | 7.4 | 4.4 | 7.7 | 3.4 | 7.3 |
| Cyclohexane | 3.9 | 4.9 | 4.5 | 6.2 | 4.4 | 6.7 | 4.0 | 6.8 | 3.3 | 6.9 |
| Butyl cresol | 5.5 | 6.3 | 4.8 | 6.3 | 4.2 | 6.8 | 3.6 | 6.1 | 3.1 | 5.7 |
| Castor oil | * | * | 30.0 | * | 18.0 | 41.0 | | – | – | – |
| Terpineol | 9.3 | 10.8 | 7.6 | 10.2 | 6.4 | 10.0 | – | – | – | – |

* Indicates that a homogeneous mixture could not be obtained.

The authors also give diagrams showing the amounts of the third solvent required at temperatures from about — 20 to + 20°.

It is pointed out by Boutaric and Corbet, 1927, that in cases where the determination of the end point of limiting miscibility is rendered difficult by nearness of the refractive indices of the liquids or when the critical solution temperature is very low, the presence of a third solvent may overcome these difficulties. Illustrative results are given for the system $CH_3OH$ + benzene to which different amounts of oil of coloza were added and for the systems $C_2H_5OH$ + benzene and $C_2H_5OH$ + several gasolines to which definite percentages of $H_2O$ were added.

### Mutual Miscibility Temperature of a Mixture of Ethyl Alcohol and Paraffine. (Howard and Patterson, 1926.)

To a mixture of equal weights of absolute $C_2H_5OH$ and paraffine (b. pt. 168-180°), which had a mutual miscibility temperature of 19°.9, increasing amounts of a large number of salts were added and the elevation of the mutual miscibility temperature determined. Results showing the effect of increasing amounts of water upon the mutual miscibility temperature are also given. The critical solution temperature of ethyl alcohol and paraffine was found to be at 33°.5 and at 13 per cent $C_2H_5OH$.

### Reciprocal Solubility of Ethyl Alcohol and Carbon Tetrachloride. (Wieth, 1929.)

| t° | Gms. $CCl_4$ per 100 gms. sat. sol. | t° | Gms. $CCl_4$ per 100 gms. sat. sol. |
|---|---|---|---|
| | | −38 | 50.8 |
| −58.5 | 26.4 | −35 | 57.7 |
| −52.5 | 31.7 | −30 | 70.8 |
| −39.0 | 49.1 | | |

## Equilibrium in the System Ethyl Alcohol, Ethyl Ether and Water.

(Åland, 1932, 1933, 1934a.)

The binodal curve was located by titrating a carefully made mixture of $C_2H_5OH$ + $(C_2H_5)_2O$ with $H_2O$. The points on the binodal curve which correspond to conjugate layers, were found by preparing mixtures which yield two layers and analytically determining the ether content of each of these.

Results at 0°

| Gms. per 100 gms. homogeneous mixture | | |
|---|---|---|
| $C_2H_5OH$ | $(C_2H_5)_2O$ | $H_2O$ |
| 8.7 | 10.5 | 80.7 |
| 18.6 | 11.0 | 70.4 |
| 25.3 | 17.3 | 57.4 |
| 27.7 | 29.4 | 42.8 |
| 27.8 | 39.3 | 32.8 |
| 26.8 | 48.2 | 25.0 |
| 24.0 | 58.0 | 18.0 |
| 20.8 | 66.1 | 18.9 |
| 16.0 | 74.7 | 8.9 |
| 11.2 | 82.9 | 5.7 |
| 4.1 | 93.3 | 2.6 |

Results at −15°

| Gms. per 100 gms. homogeneous mixture | | |
|---|---|---|
| $C_2H_5OH$ | $(C_2H_5)_2O$ | $H_2O$ |
| 5.8 | 91.3 | 2.8 |
| 11.3 | 83.3 | 5.3 |
| 11.8 | 82.2 | 5.8 |
| 14.9 | 77.1 | 7.9 |
| 20.8 | 66.0 | 13.1 |
| 24.7 | 55.6 | 19.7 |
| 26.9 | 46.9 | 26.1 |
| 27.6 | 41.4 | 31.0 |

The following results are given for the composition of conjugate layers at −15°.

| Gms. per 100 gms. upper layer | | |
|---|---|---|
| $C_2H_5OH$ | $(C_2H_5)_2O$ | $H_2O$ |
| 8.2 | 87.0 | 4.3 |
| 13.5 | 79.6 | 6.8 |
| 18.4 | 71.0 | 10.6 |
| 20.4 | 66.7 | 12.9 |
| 25.7 | 52.5 | 21.8 |
| 27.3 | 28.5 | 44.3 |

| Gms. per 100 gms. lower layer | | |
|---|---|---|
| $C_2H_5OH$ | $(C_2H_5)_2O$ | $H_2O$ |
| 17.8 | 12.2 | 69.9 |
| 20.5 | 12.9 | 66.6 |
| 23.2 | 15.1 | 61.7 |
| 23.9 | 16.9 | 60.1 |
| 26.7 | 22.3 | 51.0 |
| 27.3 | 25.1 | 47.6 |

The following results are given for the composition of the quadruple points corresponding to the intersection of the miscibility and freezing-point curves.

| t° | Gms. per 100 gms. homogeneous mixture | | t° | Gms. per 100 gms. homogeneous mixture | | t° | Gms. per 100 gms. homogeneous mixture | |
|---|---|---|---|---|---|---|---|---|
| | $C_2H_5OH$ | $(C_2H_5)_2O$ | | $C_2H_5OH$ | $(C_2H_5)_2O$ | | $C_2H_5OH$ | $(C_2H_5)_2O$ |
| − 3.78 | 0.0 | 12.8 | −17.95 | 20.8 | 14.2 | −20.65 | 22.2 | 83.25 |
| − 5.95 | 4.0 | 12.65 | −21.50 | 27.0 | 23.5 | −16.5 | 9.8 | 85.6 |
| − 8.40 | 7.8 | 12.35 | −21.65 | 27.4 | 33.8 | − 8.0 | 1.7 | 96.8 |
| −12.86 | 14.2 | 12.2 | −21.5 | 26.95 | 44.15 | − 3.7 | 0.0 | 99.1 |

## The Freezing-points of Mixtures of Ethyl Alcohol and Ethyl Ether.

(Lelande, 1933, 1934a.)

| t° | Gms. $C_2H_5OH$ per per 100 gms. mixture | Solid Phase | t° | | Gms. $C_2H_5OH$ per per 100 gms. mixture | Solid Phase |
|---|---|---|---|---|---|---|
| -116.32 | 0.0 | $(C_2H_5)_2O$ | 123.09 | | 49.23 | $(C_2H_5)_2O$ |
| -117.03 | 2.09 | " | 124.37 | | 55.44 | " |
| -117.32 | 4.02 | " | 125.05 | Eutec. | 57.85 | " + $C_2H_5OH$ |
| -117.74 | 7.43 | " | 124.38 | | 59.97 | $C_2H_5OH$ |
| -118.32 | 13.55 | " | 123.32 | | 64.48 | " |
| -118.64 | 16.53 | " | 122.32 | | 69.22 | " |
| 119.2 | 22.13 | " | 121.51 | | 72.08 | " |
| 119.37 | 25.18 | " | 119.53 | | 80.28 | " |
| 120.3 | 32.81 | " | 118.32 | | 85.24 | " |
| 121.32 | 39.29 | " | 117.67 | | 87.17 | " |
| 122.48 | 45.94 | " | 114.5 | | 100 | " |

The previous results of Desmaroux, 1928, and Saphir, 1929, differ somewhat from the above values.

The author also determined the freezing-points of the ternary mixtures of ethyl alcohol, ethyl ether and water. The ternary eutectic is at -127° and contains 55.5 gms. $C_2H_5OH$, 39.5 gms. $(C_2H_5)_2O$, and 5.0 gms. $H_2O$ per 100 gms. of mixture.

## Reciprocal Solubility of Ethyl Alcohol, Glycol and a Third Solvent.

(Trimble and Fraser, 1929.)

The determinations were made by the titration method. The density of the glycol was 1.1131 at 20°.

$C_2H_5OH + CH_2OH.CH_2OH + C_6H_6$ at 25°

| cc per 100 cc homogeneous mixture | | |
|---|---|---|
| $C_2H_5OH$ | $CH_2OH.CH_2OH$ | $C_6H_6$ |
| 4.1 | 93.0 | 2.0 |
| 16.9 | 74.2 | 8.9 |
| 23.8 | 61.8 | 14.4 |
| 27.0 | 55.7 | 17.5 |
| 30.3 | 42.8 | 27.0 |
| 30.0 | 32.9 | 37.0 |
| 22.2 | 17.2 | 60.5 |
| 10.5 | 4.8 | 86.0 |

$C_2H_5OH + CH_2OH.CH_2OH + C_6H_5NO_2$ at 29°.

| cc per 100 cc homogeneous mixture | | |
|---|---|---|
| $C_2H_5OH$ | $CH_2OH.CH_2OH$ | $C_6H_5NO_2$ |
| 10.1 | 83.2 | 6.8 |
| 21.1 | 63.4 | 15.5 |
| 23.6 | 59.0 | 17.4 |
| 28.3 | 43.5 | 28.3 |
| 27.8 | 32.5 | 39.7 |
| 24.6 | 24.8 | 50.5 |
| 16.8 | 12.4 | 70.8 |
| 11.8 | 6.9 | 81.3 |

$C_2H_5OH + CH_2OH.CH_2OH + C_6H_5CH_3$

| cc per 100 cc homogeneous mixture | | |
|---|---|---|
| $C_2H_5OH$ | $CH_2OH.CH_2OH$ | $C_6H_5CH_3$ |
| 5.7 | 91.5 | 2.9 |
| 26.3 | 63.8 | 10.0 |
| 31.6 | 52.5 | 15.8 |
| 35.5 | 39.7 | 24.8 |
| 34.2 | 29.3 | 36.6 |
| 29.6 | 20.1 | 50.3 |
| 20.7 | 10.9 | 68.3 |

$C_2H_5OH + CH_2OH.CH_2OH + C_6H_4(CH_3)_2$

| cc per 100 cc homogeneous mixture | | |
|---|---|---|
| $C_2H_5OH$ | $CH_2OH.CH_2OH$ | $C_6H_4(CH_3)_2$ |
| 20.2 | 76.0 | 3.9 |
| 38.5 | 48.9 | 12.5 |
| 42.2 | 38.2 | 19.6 |
| 41.2 | 29.0 | 29.7 |
| 37.3 | 20.6 | 42.2 |
| 33.0 | 16.4 | 50.5 |
| 27.6 | 11.8 | 60.5 |
| 20.0 | 7.1 | 73.0 |

## Equilibrium in the System Ethyl Alcohol, Glycerol and Benzene at 25°.

(McDonald, 1940.)

The determinations for the binodal curve were made by the titration method. Tie lines were located by means of viscosimetric determinations made of conjugate layers prepared from appropriate amounts of the three liquids.

| Gms. per 100 gms. lower layer | | | Gms. per 100 gms. upper layer | | |
|---|---|---|---|---|---|
| $C_2H_5OH$ | $CH_2OHCHOHCH_2OH$ | $C_6H_6$ | $C_2H_5OH$ | $CH_2OHCHOHCH_2OH$ | $C_6H_6$ |
| 8.8 | 89.8 | 1.4 | 1.4 | 0.6 | 98.4 |
| 15.9 | 81.9 | 3.2 | 6.3 | 0.3 | 93.4 |
| 19.1 | 76.5 | 4.4 | 10.3 | 0.7 | 89.0 |
| 24.0 | 69.7 | 6.3 | 16.1 | 1.1 | 82.8 |
| 28.1 | 62.9 | 9.0 | 21.7 | 2.2 | 76.1 |
| 32.0 | 54.6 | 13.4 | 26.8 | 4.6 | 68.6 |
| 36.3 | 38.7 | 25.0 | 32.3 | 10.4 | 57.3 |

The compositions of the co-existing phases, the total pressures and the calculated partial pressures for the system Ethyl Alcohol + n Heptane at 30°, are given by Ferguson, Freed and Morris, 1933.

## Freezing-points of Mixtures of Ethyl Alcohol and Carbon Tetrachloride.

(Wyatt, 1928.)

The results are given only in the form of a diagram from which the following approximate values were read.

| t° | Mol. Percent $CCl_4$ | Solid Phase | t° | Mol. Percent $CCl_4$ | Solid Phase |
|---|---|---|---|---|---|
| -114.5 | 0 | $C_2H_5OH$ | -47.6 | 44.6 | $C_2H_5OH.?CCl_4 \rightarrow CCl_4$ |
| -118. Eutec. | 11 | " + $C_2H_5OH.?CCl_4$ | -42 | 50 | $CCl_4$ |
| - 76 | 20 | $C_2H_5OH.?CCl_4$ | -36 | 60 | " |
| - 58 | 30 | " | -28 | 80 | " |
| - 50 | 40 | " | - 24 | 100 | " |

## Freezing-points of Mixtures of Ethyl Alcohol and Acetone.

(Saphir, 1929.)

| t° | Gms. $(CH_3)_2CO$ per 100 gms. mixture | Solid Phase | t° | Gms. $(CH_3)_2CO$ per 100 gms. mixture | Solid Phase |
|---|---|---|---|---|---|
| -114.1 | 0 | $C_2H_5OH$ | -104.8 | 60.3 | $(CH_3)_2CO$ |
| -116.6 | 9.6 | " | -102.1 | 74.2 | " |
| -118.7 | 20.5 | " | -100.0 | 86.5 | " |
| -119.1 | 25.0 Eutec. | " + $(CH_3)_2CO$ | - 95.6 | 100 | " |
| -108.7 | 43.5 | $(CH_3)_2CO$ | | | |

## Mutual Solubility of Benzene and Ethyl Alcohol. Freezing-point Method.

(Viala, 1914; see also Rozsa, 1911 and Pickering, 1893.)

| t°. | Gms. $C_6H_6$ per 100 Gms. Sol. | t°. | Gms. $C_6H_6$ per 100 Gms. Sol. | t°. | Gms. $C_6H_6$ per 100 Gms. Sol. |
|---|---|---|---|---|---|
| −113.9 | 0 | −60 | 19.3 | −10 | 57.6 |
| −100 | 8 | −50 | 24.1 | 0 | 85 |
| − 90 | 10 | −40 | 29.8 | 1 | 93 |
| − 80 | 12 | −30 | 37 | 5.5 | 100 |
| − 70 | 15 | −20 | 45.7 | | |

More recent results for this system in the form of a diagram are given by Wyatt, 1928. The eutectic was found to be at 2.5 Mol. % $C_6H_6$ and -118°

Freezing Points of Mixtures of Ethyl Alcohol and Phenol. (Perrakis, 1925.)

An ordinary cryoscopie apparatus was used and the usual precautions taken.

| t° of cryst. | Mol. per cent $C_2H_5OH$ in sat. sol. | t° of cryst. | Mol. per cent $C_2H_5OH$ in sat. sol. |
|---|---|---|---|
| −30..... | 49.23 | 17.1..... | 19.38 |
| −15.2..... | 41.00 | 22.8..... | 16.25 |
| − 4.7..... | 35.00 | 32.55..... | 7.29 |
| + 2.6..... | 30.91 | 39.9..... | 0.00 |
| 9.9..... | 25.09 | | |

Similar data are given for mixtures of ethyl alcohol and phenyl ether $(C_6H_5)_2O$.

Freezing-point lowering data for mixtures of ethyl alcohol and hydrochloric acid are given by Maass and McIntosh, 1913.

Freezing-point data are given for:

$C_2H_5OH$ + Chloral (Leopold, 1909.)
" + $(C_2H_5)_2$.HBr (Maass and Russel, 1919.)
" + $CH_3OH$ (Saphir, 1929.)
" + $CH_3COOC_2H_5$ (Saphir, 1929; Lelande, 1933.)
" + Acetamide + Phenol (Kremann & Wenzig, 1917; Speyers, 1902.)

## METHYL UREA $NH_2.CONHCH_3$.

Freezing-point data for mixtures of methyl urea and phenol are given by Kremann, 1910.

(Dubroca, 1907.)

## GLYCOL (Ethylene glycol) $CH_2OH.CH_2OH$.

Solubility of Glycol in Water Determined by the Freezing-point Method.
(Ewert, 1937.)

| t° | Gm. Mols. $CH_2OH.CH_2OH$ per 100 gm. mols. sat. sol. | Solid Phase | t° | Gm. Mols. $CH_2OH.CH_2OH$ per 100 gm. mols. sat. sol. | Solid Phase |
|---|---|---|---|---|---|
| -14.1 | 10.5 | $H_2O$ | -63.3 Eutec. | 47.5 | 1.2 + 3.2 |
| -20.9 | 14.1 | " | -54.6 | 50.2 | 3.2 |
| -28.3 | 18.9 | " | -40.7 | 60.9 | " |
| 41.8 | 24.9 | " | -49.4 Eutec. | 66.0 | "+$CH_2OH.CH_2OH$ |
| 51.2 Eutec. | 28 | " + 1.2 | -45.3 | 67.8 | $CH_2OH.CH_2OH$ |
| 49.6 | 31.8 | 1.2 | -36.4 | 75.3 | " |
| 49.6 | 34.1 | " | -22.4 | 90.1 | " |
| -58.6 | 44.0 | " | -12.8 | 100.0 | " |

1.2 = $CH_2OH.CH_2OH.2H_2O$; 3.2 = $3CH_2OH.CH_2OH.2H_2O$.

100 cc. sat. solution of glycol in Water contain 19.64 gm. $CH_2OH.CH_2OH$ at 21°.
" " " " 0.02 *n* $CH_3COOK$ " 17.20 " " "
(Pfeiffer and Angern, 1924.)

## Critical Solution Temperatures of Separation of Mixtures of Glycol and Other Compounds.

(Lecat, 1927, 1927a, 1928, 1929, 1930, 1930a, 1930b.)

| Mixture of $CH_2OH.CH_2OH$ and: | $t^0$ of Separation | Percent $CH_2OH.CH_2OH$ in mixture |
|---|---|---|
| Acetophenone | 114.5 | 52 |
| i Amyl benzoate | 182 | 66 |
| Anisol | 134.5 | 10.5 |
| Benzyl acetate | 100 | 45 |
| Bornyl acetate | 110 | 53 |
| Bromoform | 142 | 6.5 |
| n Butyl benzoate | 178 | — |
| i " " | 172 | — |
| Carvon | 97.4 | 61 |
| p chloro nitro-benzene | 136.5 | 58 |
| Citronellal | 165 | 53 |
| p Cresol methylether | 152 | 23 |
| Di methyl aniline | 171.4 | 33.5 |
| n Decanol | 105 | — |
| Ethyl acetate | 57 | — (1) |
| " benzoate | 137 | 46.5 |
| " aniline | 126.5 | 43 |
| Ethylene bromide | 102 | 3.5 |
| Eugenol methyl ester | 144 | 68.5 |
| β Iso safrol | 172 | 64 |
| Methyl acetate | 26.8 | — (1) |
| " benzoate | 109.5 | — (1) |
| " aniline | 70 | 40.2 |
| p " acetophenone | 77.5 | 60 |
| " cinnamate | 101.5 | 85 |
| " heptenone | 65 | 22.5 |
| " n hexyl ketone | 66 | 21 |
| " salicylate | 143 | 48 |
| Nitro benzene | 120.2 | 59 |
| o " toluene | 142 | 48.5 |
| p " " | 141.5 | 63.5 |
| Phenyl acetate | 67.7 | 34 |
| Propyl benzoate | 16 5. | 55 |
| Safrol | 187.5 | 55 |
| s Tetra chloro ethane | 88.5 | 7 |
| o Toluidine | - 8.5 | 42.5 |

(1) Muchin and Machina, 1930, 1931.

## Equilibrium in Ternary Systems Composed of Glycol Acetone and Another Compound.

(Trimble and Fraser, 1929.)

The determinations of the binodal curves were made by titrating to the appearance or disappearance of clouding. Since glycol cannot be satisfactorily measured in ordinary volumetric apparatus it was weighed out from a dropping bottle of the ground-in pipet type and the volume calculated from the d = 1.1131 at 20°. Tie lines were determined by the method of Miller and McPherson, 1908. This method rests upon the principle that the distance from the point representing the gross composition of a mixture yielding two immiscible layers, to the ends of the tie lines through this point are inversely proportional to the volumes of the phases into which the mixture separates.

Results for mixtures of:

Glycol + Acetone + Xylene

| cc per 100 cc of homogeneous mixture | | |
|---|---|---|
| $CH_2OH.CH_2OH$ | $(CH_3)_2CO$ | $C_6H_4(CH_3)_2$ |
| 70.0 | 4.0 | 26.1 |
| 45.0 | 12.6 | 42.4 |
| 34.0 | 19.0 | 46.8 |
| 23.3 | 24.2 | 52.5 |
| 14.8 | 33.4 | 51.8 |
| 11.2 | 37.7 | 51.3 |
| 5.6 | 47.0 | 47.3 |
| 2.2 | 54.5 | 43.3 |
| 1.3 | 65.8 | 33.0 |

Glycol + Acetone + Toluene

| cc per 100 cc of homogeneous mixture | | |
|---|---|---|
| $CH_2OH.CH_2OH$ | $(CH_3)_2CO$ | $C_6H_5CH_3$ |
| 92.0 | 4.0 | 4.2 |
| 54.6 | 11.8 | 33.6 |
| 37.9 | 19.8 | 42.5 |
| 29.1 | 25.1 | 45.6 |
| 18.8 | 32.8 | 48.4 |
| 10.2 | 43.0 | 46.8 |
| 6.6 | 49.8 | 43.8 |
| 4.6 | 55.3 | 40.0 |
| 3.3 | 61.0 | 36.0 |
| 2.5 | 84.0 | 14.5 |

## Equilibrium in Ternary Systems Composed of Glycol Acetone and Another Compound—Continued.

(Trimble and Fraser, 1929.)

| Vol. % $(CH_3)_2CO$ in | |
|---|---|
| Glycol rich layer | Glycol poor layer |
| 18.0 | 22.3 |
| 25.5 | 35.2 |
| 31.2 | 46.0 |
| 45.0 | 52.0 |

Glycol + Acetone + Chloro benzene

| cc per 100 cc homogeneous mixture | | |
|---|---|---|
| $CH_2OHCH_2OH$ | $(CH_3)_2CO$ | $C_6H_5Cl$ |
| 78.7 | 4.6 | 16.7 |
| 50.9 | 15.0 | 34.1 |
| 37.8 | 22.2 | 40.0 |
| 25.5 | 30.0 | 44.5 |
| 15.9 | 37.5 | 46.5 |
| 8.1 | 47.6 | 44.4 |
| 4.7 | 55.6 | 39.8 |
| 3.4 | 60.7 | 36.0 |
| 2.4 | 66.0 | 31.6 |

| Vol. % $(CH_3)_2CO$ in: | |
|---|---|
| Glycol rich layer | Glycol poor layer |
| 16.8 | 23.0 |
| 24.0 | 36.0 |
| 27.0 | 42.0 |
| 31.6 | 46.0 |

Glycol + Acetone + Bromo benzene

| cc per 100 cc homogeneous mixture | | |
|---|---|---|
| $CH_2OH.CH_2OH$ | $(CH_3)_2CO$ | $C_6H_5Br$ |
| 78.6 | 4.3 | 17.2 |
| 51.3 | 14.0 | 34.7 |
| 38.0 | 21.0 | 40.3 |
| 16.8 | 36.8 | 46.4 |
| 12.5 | 41.1 | 46.4 |
| 8.7 | 47.3 | 44.0 |
| 5.0 | 55.1 | 39.9 |
| 2.5 | 64.4 | 33.1 |
| 0.9 | 74.3 | 24.8 |

| Vol. % $(CH_3)_2CO$ in: | |
|---|---|
| Glycol rich layer | Glycol poor layer |
| 8.0 | 12.0 |
| 16.8 | 24.0 |
| 24.0 | 36.0 |
| 32.0 | 45.7 |

| Vol. % $(CH_3)_2CO$ in | |
|---|---|
| Glycol rich layer | Glycol poor layer |
| 16.0 | 24.0 |
| 23.0 | 37.0 |
| 30.0 | 45.7 |
| 39.0 | 46.8 |

Glycol + Acetone + Benzene

| cc per 100 cc homogeneous mixture | | |
|---|---|---|
| $CH_2OH.CH_2OH$ | $(CH_3)_2CO$ | $C_6H_6$ |
| 90.7 | 3.9 | 5.4 |
| 72.2 | 8.4 | 19.4 |
| 60.2 | 12.9 | 26.9 |
| 49.8 | 17.5 | 32.7 |
| 32.4 | 27.8 | 39.8 |
| 14.1 | 41.3 | 44.6 |
| 9.1 | 48.2 | 42.6 |
| 4.9 | 57.2 | 37.6 |
| 1.2 | 74.0 | 24.8 |
| 0.2 | 90.8 | 9.9 |

| Vol. % $(CH_3)_2CO$ in: | |
|---|---|
| Glycol rich layer | Glycol poor layer |
| 10.2 | 6.8 |
| 16.0 | 25.0 |
| 22.0 | 37.8 |
| 32.2 | 44.0 |

Glycol + Acetone + Nitro benzene

| cc per 100 cc homogeneous mixture | | |
|---|---|---|
| $CH_2OH.CH_2OH$ | $(CH_3)_2CO$ | $C_6H_5NO_2$ |
| 87.0 | 4.3 | 8.7 |
| 76.8 | 7.7 | 15.4 |
| 55.5 | 16.7 | 27.8 |
| 45.0 | 22.5 | 32.6 |
| 31.3 | 31.3 | 37.0 |
| 20.1 | 40.3 | 39.7 |
| 12.2 | 48.8 | 39.1 |
| 7.6 | 57.4 | 35.0 |
| 4.3 | 64.8 | 31.0 |
| 0.1 | 90.8 | 9.1 |

| Vol. % $(CH_3)_2CO$ in: | |
|---|---|
| Glycol rich layer | Glycol poor layer |
| 17.4 | 22.8 |
| 19.1 | 31.0 |
| 23.0 | 36.7 |
| 29.1 | 39.6 |

**METHYL SULFATE** $(CH_3)_2SO_4$.

100 cc. $H_2O$ dissolve 2.8 gms dimethyl sulfate at 18°. Solution is, however, accompanied or quickly followed by decomposition. (Boulin and Simon, 1920.)

RECIPROCAL SOLUBILITY OF METHYL SULFATE AND OIL OF TURPENTINE. (Dubroca 1907.)

The determinations were made by the synthetic method (sealed tubes).

The $d_{25}$ of the oil of turpentine, $C_{10}H_{16}$, was 0.8602, its absolute index of refraction for yellow light at 25° was 1.467 and its rotation in a 100-mm. tube was −32.25°.

| t°. | Gms. $(CH_3)_2SO_4$ per 100 Gms. $(CH_3)_2SO_4$ Rich Layer. | Gms. $(CH_3)_2SO_4$ per 100 Gms. $C_{10}H_{16}$ Rich Layer. | t°. | Gms. $(CH_3)_2SO_4$ per 100 Gms. $(CH_3)_2SO_4$ Rich Layer. | Gms. $(CH_3)_2SO_4$ per 100 Gms. $C_{10}H_{16}$ Rich Layer. |
|---|---|---|---|---|---|
| 30 | 95 | 4 | 80 | 87 | 13 |
| 40 | 93 | 5 | 90 | 84 | 17 |
| 50 | 92 | 6 | 100 | 76 | 27 |
| 60 | 91 | 8 | 105 | 68 | 37 |
| 70 | 89 | 10 | 108.2 (crit. t.) | 50.5 | |

The results are influenced appreciably by the age and purity of the products and by the length of time the mixtures are kept in the sealed tubes. Somewhat different results were obtained with a sample of turpentine containing 5 vol. % of white spirit.

ETHYL Hydrogen **SULFATE** $C_2H_5HSO_4$.

FREEZING-POINTS OF MIXTURES OF ETHYL HYDROGEN SULFATE AND WATER. (Berthoud, 1929.)

| t° | Mol. % $C_2H_5HSO_4$ | Solid Phase | t° | Mol. % $C_2H_5HSO_4$ | Solid Phase |
|---|---|---|---|---|---|
| - 6 | 3.3 | Ice | 5.1 | 52.0 | $C_2H_5HSO_4.H_2O$ |
| -17 | 7.4 | " | 4.4 | 53.8 | " |
| -23.5 | 9.2 | " | - 1.4 | 62.0 | " |
| — Eutec. — | | "+ $C_2H_5.HSO_4.H_2O$ | - 5.0 | 64.0 | " |
| -70 | 27.5 | $C_2H_5HSO_4.H_2O$ | -11.0 | 68.5 | " |
| -58 | 29.4 | " | -25.2 | 75.4 | " |
| -35 | 32.7 | " | -35.5 | 79.5 | " + $C_2H_5HSO_4$ |
| - 9.5 | 37.7 | " | -32.3 | 80.3 | $C_2H_5HSO_4$ |
| - 2.5 | 40.2 | " | -25 | 86.0 | " |
| + 4.3 | 45.5 | " | -21 | 90.4 | " |
| 5.1 | 48.0 | " | -17 | 100.0 | " |
| 5.4 m.p. | 50.5 | " | | | |

**ETHYL** Hydrogen **SULFATE** $C_2H_5HSO_4$.

SOLUBILITY IN ETHYL ETHER CONTAINING FREE SULFURIC ACID AT 30° (Hamid, Singh and Dunnicliff, 1926.)

| Per cent free $H_2SO_4$ | Per cent $C_2H_5HSO_4$. | Per cent free $H_2SO_4$. | Per cent $C_2H_5HSO$ |
|---|---|---|---|
| 0.092 | 1.125 | 0.372 | 0.722 |
| 0.152 | 1.061 | 0.516 | 0.509 |
| 0.186 | 0.999 | 0.533 | 0.470 |
| 0.314 | 0.818 | 4.06 | 0.242 |

By extrapolation the solubility of pure ethyl hydrogen sulfate in pure ether should be about 1.27 gms. $C_2H_5HSO_4$ per 100 gms. dry ether at 30°.

## DI METHYL AMINE $(CH_3)_2NH$.

The solubility of dimethyl amine in water at 60°, calculated from the vapor pressures determined by an aspiration method was found by Doyer, 1890, to be 188 in terms of the Bunsen Absorpition Coefficient and 230 in terms of the Ostwald Solubility Expression, l, at vapor pressure of 90.3 mm Hg.

Freezing-point data for mixtures of dimethyl amine and water are given by Pickering, 1893.

### Distribution of Dimethyl Amine at 25° Between Water and Ether.

(Smith, 1921, 1922.)

| Millimols. $(CH_3)_2NH$ per liter of | | | Millimols. $(CH_3)_2NH$ per liter of | | |
|---|---|---|---|---|---|
| $H_2O$ layer ($C_1$). | $(C_2H_5)_2O$ layer ($C_2$). | $\frac{C_2}{C_1}$. | $H_2O$ layer ($C_1$). | $(C_2H_5)_2O$ layer ($C_2$). | $\frac{C_2}{C_1}$. |
| 1.37 | 0.33 | 0.241 | 4.35 | 1.025 | 0.236 |
| 1.85 | 0.425 | 0.230 | 5.22 | 1.26 | 0.242 |
| 2.55 | 0.600 | 0.235 | 7.00 | 1.60 | 0.228 |
| 2.81 | 0.63 | 0.224 | 13.5 | 3.05 | 0.226 |

### Distribution of Dimethyl Amine at 25° Between : (Smith, 1921, 1922.)

#### Water and Chloroform.

| Millimols. $(CH_3)_2NH$ per liter of | | |
|---|---|---|
| $H_2O$ layer ($C_1$) | $CHCl_3$ layer ($C_2$). | $\frac{C_2}{C_1}$. |
| 1.35 | 0.80 | 0.592 |
| 2.20 | 1.275 | 0.580 |
| 3.40 | 2.00 | 0.588 |
| 4.55 | 2.62 | 0.582 |
| 5.85 | 3.40 | 0.582 |

#### Water and Xylene.

| Millimols. $(CH_3)_2NH$ per liter of | | |
|---|---|---|
| $H_2O$ layer ($C_1$). | $C_6H_4(CH_3)_2$ layer ($C_2$). | $\frac{C_2}{C_1}$. |
| 1.786 | 0.214 | 0.120 |
| 3.55 | 0.430 | 0.121 |
| 8.97 | 1.12 | 0.125 |
| 17.78 | 2.22 | 0.125 |

#### Acetone and Glycerol.

| Millimols. $(CH_3)_2NH$ per liter of | | |
|---|---|---|
| Acetone layer (A). | Glycerol layer (G). | $\frac{A}{G}$. |
| 1.125 | 2.25 | 0.510 |
| 2.425 | 4.325 | 0.561 |
| 4.775 | 7.525 | 0.635 |
| 10.6 | 15.8 | 0.672 |
| 20.1 | 27.8 | 0.723 |

### Distribution of Dimethyl amine at 25° Between:

(Herz and Stanner, 1927.)

#### Water and Benzene

| Gm. Mols. $(CH_3)_2NH$ per liter | | $\frac{C_2}{C_1}$ |
|---|---|---|
| $H_2O$ layer $C_1$ | $C_6H_6$ layer $C_2$ | |
| 0.3212 | 0.0394 | 0.123 |
| 0.6243 | 0.0576 | 0.092 |
| 0.9061 | 0.0788 | 0.087 |
| 1.2001 | 0.1061 | 0.088 |

#### Water and Toluene

| Gm. Mols. $(CH_3)_2NH$ per liter | | | $\frac{C_2}{C_1}$ |
|---|---|---|---|
| $H_2O$ layer $C_1$ | $C_6H_5CH_3$ layer $C_2$ | | |
| 0.3182 | 0.0333 | | 0.105 |
| 0.6243 | 0.0503 | | 0.081 |
| 1.9273 | 0.0655 | | 0.071 |
| 1.2273 | 0.0847 | | 0.069 |

### Distribution of Dimethyl Amine Between Water and Toluene.

(Moore and Winmill, 1912.)

| t° | Gm. Equiv. $(CH_3)_2NH$ per liter aq. layer | Dist. Coef. |
|---|---|---|
| 18 | 0.0759 | 23.28 |
| " | 0.0975 | 23.29 |
| | 0.1203 | 19.01 |
| 25 | 0.1010 | 19.05 |
| " | 0.1003 | 13.38 |
| 32.35 | 0.1043 | 13.36 |
| " | | |

## DI METHYL AMINE HYDROCHLORIDE $(CH_3)_2.NH.HCl$.

100 gms. $H_2O$ dissolve 369.2 gms. $(CH_3)_2NH.HCl$ at 25°. (Peddle and Turner, 1913.)

100 gms. $CHCl_3$ dissolve 16.91 gms. $(CH_3)_2NH.HCl$ at 25°. (Peddle and Turner, 1913.)

## DI METHYL AMINE CHLORO PLATINATE $(CH_3)_2NH.H_2PtCl_6$.

### Solubility of Dimethyl Amine Chloro Platinate in Aqueous Ethyl Alcohol at 0°.

(Bertheaume, 1910.)

| Concentration of Aq. Alcohol (Wt. or Vol. %?) | Gms. $(CH_3)_2NH.H_2PtCl_6$ per 100 gms. solvent |
|---|---|
| 60 | 0.996 |
| 70 | 0.558 |
| 80 | 0.325 |
| 90 | 0.110 |
| 100 | 0.0048 |

## ETHYL AMINE $C_2H_5.NH_2$.

Freezing-point data for mixtures of ethyl amine and water are given by Guthrie, 1884, and Pickering, 1893.

The solubility of ethyl amine in water at 60°, calculated from the vapor pressures determined by an aspiration method was found by Doyer, 1890, to be 321 in terms of the Ostwald Solubility Expression, $l$, and 263 in terms of the Bunsen Absorption Coefficient, $\beta$, at a vapor pressure of 64.5 mm. Hg.

### Distribution of Ethyl Amine at 25° Between: (Smith, 1921-1922.)

#### Water and Chloroform.

| Millimols. $C_2H_5.NH_2$ per liter | | |
|---|---|---|
| $H_2O$ layer ($C_1$). | $CHCl_3$ layer ($C_2$). | $\frac{C_2}{C_1}$. |
| 1.50 | 0.55 | 0.366 |
| 2.525 | 1.00 | 0.396 |
| 4.30 | 1.80 | 0.418 |
| 10.20 | 4.80 | 0.470 |
| 18.45 | 9.45 | 0.512 |
| 25.50 | 20.70 | 0.780 |

#### Water and Ether.

| Millimols. $C_2H_5.NH_2$ per liter | | |
|---|---|---|
| $H_2O$ layer ($C_1$). | $(C_2H_5)_2O$ layer ($C_2$). | $\frac{C_2}{C_1}$. |
| 2.550 | 0.450 | 0.176 |
| 3.975 | 0.675 | 0.170 |
| 6.075 | 1.125 | 0.185 |
| 9.8 | 1.60 | 0.163 |
| 14.8 | 2.50 | 0.169 |

#### Acetone and Glycerol.

| Millimols. $C_2H_5.NH_2$ per liter | | |
|---|---|---|
| Acetone layer (A) | Glycerol layer ($G_1$). | $\frac{A}{G}$. |
| 0.67 | 1.20 | 0.558 |
| 1.25 | 1.625 | 0.77 |
| 1.26 | 1.76 | 0.715 |
| 2.25 | 2.70 | 0.835 |
| 4.76 | 4.72 | 1.01 |
| 9.76 | 8.20 | 1.19 |

#### Water and Xylene.

| Millimols. $C_2H_5.NH_2$ per liter | | |
|---|---|---|
| $H_2O$ layer ($C_1$). | $C_6H_4(CH_3)_2$ layer ($C_2$) | $\frac{C_2}{C_1}$. |
| 1.7955 | 0.2045 | 0.1140 |
| 3.654 | 0.346 | 0.0947 |
| 9.255 | 0.745 | 0.0805 |
| 19.284 | 1.496 | 0.074 |

### Distribution of Ethyl Amine Between Water and Toluene.

(Moore and Winmill, 1912.)

| Results at 18° | | Results at 25° | | Results at 32.35° | |
|---|---|---|---|---|---|
| Gm. Equiv. $C_2H_5NH_2$ per liter | Dist. Coef. | Gm. Equiv. $C_2H_5NH_2$ per liter | Dist. Coef. | Gm. Equiv. $C_2H_5NH_2$ per liter | Dist. Coef. |
| 0.0756 | 26.09 | 0.1159 | 19.13 | 0.1287 | 14.76 |
| 0.0886 | 26.14 | 0.0999 | 19.11 | 0.2479 | 14.79 |

## ETHYL AMINE HYDROCHLORIDE $C_2H_5NH_2.HCl$.

### Solubility of Ethyl Amine Hydrochloride in Water and in Chloroform at 25°.

(Peddle and Turner, 1913.)

| Solvent | Gms. $C_2H_5NH_2.HCl$ per 100 gms. solvent |
|---|---|
| Water | 279.9 |
| Chloroform | 0.17 |

## TAURINE $NH_2.CH_2.CH_2.SO_3H$.

### Solubility of Taurine in Water.

(Dalton and Schmidt, 1935.)

The results of 10 determinations at temperatures between 0° and 62° were used for calculating the solubility equation and from this the following values for 5° intervals were obtained. The results above 70° are probably less accurate than the others.

| t° | Gms. $C_2H_7SO_3$ per 100 gms. $H_2O$ | t° | Gms. $C_2H_7SO_3$ per 100 gms. $H_2O$ | t° | Gms. $C_2H_7SO_3$ per 100 gms. $H_2O$ |
|---|---|---|---|---|---|
| 0 | 3.931 | 30 | 12.38 | 60 | 27.42 |
| 5 | 4.878 | 35 | 14.49 | 65 | 30.26 |
| 10 | 5.992 | 40 | 16.78 | 70 | 33.05 |
| 15 | 7.291 | 45 | 19.26 | 75 | 35.71 |
| 20 | 8.784 | 50 | 21.88 | 100 | 45.76 |
| 25 | 10.48 | 55 | 24.62 | | |

## CACODYLIC ACID (Dimethyl Arsinic Acid) $(CH_3)_2AsO.OH$.

100 cc. $H_2O$ dissolve about 200 gms. cacodylic acid at 15°. (Squire and Caines, 1905.)
100 cc. 90% alcohol dissolve about 28.5 gms. cacodylic acid at 15°. " "

**DI METHYL HYDRAZINE** $CH_3NH.NHCH_3$.

Freezing-point data for mixtures of Dimethyl Hydrazine and Benzalazine are given by Pascal, 1914.

**ETHYLENE DI AMINE** $NH_2CH_2.CH_2NH_2$.

The Critical Solution Temperature of Ethylene Diamine and i Octane (2.2.4 Tri methyl pentane) is 112.0°.

The Critical Solution Temperature of Ethylene Diamine and n Heptane is 108.0°. (Cornish, Archibald, Murphy and Evans, 1934.)

Freezing-point data are given by Puschin and Sladovich, 1928a for mixtures of Ethylene Diamine on the one hand and phenol, o and p cresol, pyrocatechol, and guaicol on the other.

**DI IODO DI THIO CARBAMIDE** $(CSN_2H_4)_2I_2$.

100 gms. chloroform dissolve 0.6–0.7 gm. diiododithio carbamide $(CSN_2H_4)_2I_2$ at temp. not stated. (Werner, 1912.)

**Trichloro ACRYLIC ACID** $CCl_2$:CClCOOH.

Solubility of Trichloroacrylic Acid in Water

(Boeseken and Carriere, 1915.)

| t°. | Gms. $CCl_2$:CClCOOH per 100 Gms. Sat. Solution. | Solid Phase. |
|---|---|---|
| 0.0 | 0.0 | Ice |
| −0.36 | 2.0 | " |
| − 0.6 Eutec. | 4.5 | Ice + $CCl_2$:CClCOOH.2½ $H_2O$ |
| +13.7 " | 64.1 | $CCl_2$.CClCOOH.2½ $H_2O$ |
| 15.0 | 68.5 | " |
| 17.0 | 74.5 | " |
| 19.2 m. pt. | 80.0 | " |
| 17.0 Eutec. | 81.1 | $CCl_2$:CClCOOH + $CCl_2$:CClCOOH.2½ $H_2O$ |
| 20.3 " | 82.8 | $CCl_2$:CClCOOH |
| 25.0 | 84.5 | " |
| 30.0 | 86.0 | " |
| 40.0 | 89.5 | " |
| 50.0 | 92.5 | " |
| 60.0 | 94.5 | " |
| 70.0 | 98.5 | " |
| 72.9 | 100.0 | " |

Between the concentration 4.5 and 64.1 two liquid layers are formed. The percentage of $CCl_2$:CClCOOH in each is as follows:

| t°. | Gms. $CCl_2$:CClCOOH per 100 Gms. Sat. Solution. | |
|---|---|---|
| | Lower Layer. | Upper Layer. |
| 10 | 5.0 | ... |
| 20 | 5.2 | 64.1 |
| 30 | 6.0 | 63.8 |
| 40 | 7.5 | 62.2 |
| 50 | 13.0 | 59.5 |
| 55 | 18.0 | 56.0 |
| 60 | 27.0 | 49.0 |
| 62 crit. t. | 38.0 | |

The original results were plotted on cross-section paper and the above figures read from the curves.

## PROPIOLIC ACID HC:C.COOH

### Freezing-points of Mixtures of Propiolic Acid and Water.

(Straus, Heyn, and Schwemer, 1930.)

The original results are given only in the form of a diagram from which the following approximate values were read.

| t° | Gms. HC:C.COOH per 100 gms. mixture | Solid Phase | t° | Gms. HC:C.COOH per 100 gms. mixture | Solid Phase |
|---|---|---|---|---|---|
| -2.7 | 72.4 | $HC:C.COOH.H_2O$ | 9.3 | 90.0 | $3HC:C.COOH.H_2O$ |
| -1.7 | 75.0 | " | 10.0m.pt. | 92.1 | " |
| -0.3m.pt. | 79.5 | " | 8.5 | 95.0 | " |
| -0.8Eutec. | 82.8 | " + $3HC:C.COOH.H_2O$ | 7.5Eutec. | 96.2 | " + HC:C.COOH |
| +4.5 | 85.0 | $3HC:C.COOH.H_2O$ | 10.0 | 97.4 | HC:C.COOH |
| 7.5 | 87.5 | " | 18.0 | 100.0 | " |

## CyanoACETIC ACID $CH_2(CN)COOH$.

### Distribution of Cyanoacetic Acid between:

(Hantzsch and Sebalt, 1899.)

Water and Ethyl Ether.

| t°. | Gms. $CH_2(CN)COOH$ per Liter. | |
|---|---|---|
| | $H_2O$ Layer. | $(C_2H_5)_2O$ Layer. |
| 0 | 0.070 | 0.042 |
| 10 | 0.076 | 0.044 |
| 21 | 0.083 | 0.030 |
| 30 | 0.089 | 0.027 |

Water and Benzene.

| t°. | Gms. $CH_2(CN)COOH$ per Liter. | |
|---|---|---|
| | $H_2O$ Layer. | $C_6H_6$ Layer. |
| 6 | 0.067 | 0.020 |
| 25 | 0.130 | 0.019 |

## Trichlor LACTIC ACID $CCl_3.CHOH.COOH$.

### Solubility of Trichlor Lactic Acid in Aqueous Solutions of Hydrochloric Acid and of Sulfuric Acid at 25°.

(Knox and Richards, 1919.)

In Aq. Hydrochloric Acid.

| Equiv. normality. | | Equiv. normality | |
|---|---|---|---|
| HCl. | $C_3H_3O_3Cl_3$ | HCl. | $C_3H_3O_3Cl_3$. |
| 0.00 | 4.024 | 7.675 | 0.659 |
| 1.234 | 2.545 | 8.959 | 0.624 |
| 2.837 | 1.425 | 10.65 | 0.57 |
| 4.388 | 0.984 | 11 86 | 0.57 |
| 5.982 | 0.760 | 12.17 | 0.60 |

In Aq. Sulfuric Acid.

| Equiv. normality. | | Equiv. normality. | |
|---|---|---|---|
| $H_2SO_4$. | $C_3H_3O_3Cl_3$. | $H_2SO_4$. | $C_3H_3O_3Cl_3$ |
| 0.0 | 4.024 | 16.18 | 0.15 |
| 2.525 | 1.896 | 19.38 | 0.18 |
| 6.166 | 0.671 | 22.28 | 0.21 |
| 9.588 | 0.353 | 25.34 | 0.26 |
| 12.75 | 0.26 | | |

## ACROLEIN $CH_2 : CH.CHO$.

### Reciprocal Solubility of Acrolein and Water.

(Boutaric, 1920; Boutaric and Corbet, 1926.)

The temperatures of clouding and of clearing in mixtures of weighed amounts of acrolein and water were determined. Sealed tubes were used at the higher temperatures. The acrolein was stabilized by the addition of $\frac{1}{250}$ th of its weight of hydroquinol. The original determinations were plotted and the following results read from the curve. The authors also give a few results for the effect of different amounts of hydroquinol and of gallic acid upon the reciprocal solubilities. They found by extrapolation of the critical temperatures of acrolein stabilized with different amounts of hydroquinol, that the critical temperature of pure acrolein in water is 88°.2. Determinations are also given of the effect upon the critical temperature resulting from the presence of increasing amounts of soluble resin of acrolein.

| | Gms. $CH_2 : CH.CHO$ per 100 gms. | | | Gms. $CH_2 : CH.CHO$ per 100 gms. | |
|---|---|---|---|---|---|
| t°. | $H_2O$ rich layer (lower). | Acrolein rich layer (upper). | t°. | $H_2O$ rich layer (lower). | Acrolein rich layer (upper). |
| —10.... | 20.0 | 96.0 | 50..... | 25.0 | 87.5 |
| 0.... | 20.0 | 95.5 | 60..... | 29.0 | 84.5 |
| +10..... | 20.5 | 94.5 | 70..... | 34.0 | 80.0 |
| 20..... | 21.0 | 93.2 | 80..... | 41.5 | 73.0 |
| 30..... | 21.5 | 92.0 | 85..... | 48.0 | 67.0 |
| 40..... | 22.5 | 90.0 | 88 crit. t. | 56.2 | |

## αβ Dibrom PROPIONIC ACID $CH_2Br.CHBrCOOH$.

Distribution of αβ Dibrom Propionic Acid at 25° Between : (Smith, 1921, 1922.)

| Water and Chloroform. | | | Water and Ether | | | Water and Xylene. | | |
|---|---|---|---|---|---|---|---|---|
| Millimols. $C_2H_3Br_2COOH$ per liter of | | | Millimols. $C_2H_3Br_2COOH$ per liter of | | | Millimols. $C_2H_3Br_2COOH$ per liter of | | |
| $H_2O$ layer ($C_1$). | $CHCl_3$ layer ($C_2$). | $\frac{C_2}{C_1}$. | $H_2O$ layer ($C_1$). | $(C_2H_5)_2O$ layer ($C_2$). | $\frac{C_2}{C_1}$. | $H_2O$ layer ($C_1$). | Xylene layer ($C_2$). | $\frac{C_2}{C_1}$. |
| 1.85 | 0.313 | 0.169 | 0.2187 | 0.8562 | 3.92 | 3.70 | 0.50 | 0.135 |
| 2.66 | 0.560 | 0.210 | 0.2562 | 1.1312 | 4.42 | 5.20 | 0.75 | 0.144 |
| 3.54 | 0.985 | 0.278 | 0.350 | 2.1000 | 6.00 | 7.20 | 1.30 | 0.181 |
| 4.98 | 1.63 | 0.327 | 0.450 | 3.2625 | 7.25 | 7.35 | 1.45 | 0.197 |

## CHLORAL FORMAMIDE $CCl_3.CH(OH).NH.CHO$.

100 gms. $H_2O$ dissolve 5.3 gms. $CCl_3CH(OH).NHCHO$ at 25°. (U. S. P.)
100 gms. 95% alcohol dissolve 77 gms. $CCl_3CH(OH).NHCHO$ at 25°. "

## Tri chloro ETHYL CARBAMATE (Voluntal) $NH_2COOCH_2CCl_3$.

Freezing-point data are given for mixtures of Tri chloro ethyl carbamate and:

Acetyl amino antipyrine (Pfeiffer and Angern, 1926.)
Anti pyrine (Pfeiffer and Seydel, 1928.)
Pyramidon (Pfeiffer and Angern, 1926; Pfeiffer and Seydel, 1928.)
Di methyl amino antiyprine (Pfeiffer and Seydel, 1928.)

**HYDANTOIN** (Glycolyl urea) $\underline{NHCONHCO}CH_2$.

SOLUBILITY OF HYDANTOIN IN AQUEOUS SOLUTIONS OF ETHYL ALCOHOL AT 25°.
(McMeekin, Cohn and Weare, 1935.)

| Vol. Percent $C_2H_5OH$ in aq. solvent | d. of sat. sol. | Gm. Mols. $C_3H_4O_2N_2$ per liter | Vol. Percent $C_2H_5OH$ in aq. solvent | d. of sat. sol. | Gm. Mols. $C_3H_4O_2N_2$ per liter |
|---|---|---|---|---|---|
| 0.0 | 1.0105 | 0.397 | 70.0 | 0.8923 | 0.249 |
| 20.0 | 0.9846 | 0.348 | 90 | 0.8304 | 0.0987 |
| 40.0 | 0.9579 | 0.340 | 100.0 | 0.7867 | 0.0324 |
| 60.0 | 0.9207 | 0.294 | | | |

**PYRUVIC ACID** $CH_3.CO.CO\,OH$.

DISTRIBUTION OF PYRUVIC ACID AT 25°, BETWEEN : (Smith, 1921, 1922.)

Water and Chloroform.

| Millimols. $CH_3.CO.COOH$ per liter of $H_2O$ layer ($C_1$). | Millimols. $CH_3.CO.COOH$ per liter of $CHCl_3$ layer ($C_2$). | $\frac{C_2}{C_1}$. |
|---|---|---|
| 19.90 | 1.00 | 0.0592 |
| 31.2 | 2.00 | 0.064 |

Water and Ether.

| Millimols. $CH_3.CO.COOH$ per liter of $H_2O$ layer ($C_1$). | Millimols. $CH_3.CO.COOH$ per liter of $(C_2H_5)_2O$ layer ($C_2$). | $\frac{C_2}{C_1}$. |
|---|---|---|
| 3.65 | 0.55 | 0.151 |
| 5.00 | 0.80 | 0.160 |
| 7.05 | 1.15 | 0.163 |
| 14.10 | 2.40 | 0.170 |

Water and Xylene.

| Millimols. $CH_3.CO.COOH$ per liter of $H_2O$ layer ($C_1$). | Millimols. $CH_3.CO.COOH$ per liter of Xylene layer ($C_2$). | $\frac{C_2}{C_1}$. |
|---|---|---|
| 19.6 | 0.40 | 0.0204 |
| 45.8 | 1.10 | 0.024 |
| 63.7 | 1.85 | 0.029 |

The freezing-points of mixtures of pyruvic acid and phosphorus acid are given by Redfield and King, 1936.

**MALONIC ACID** $CH_2(COOH)_2$.

SOLUBILITY IN WATER.
(Klobbie, 1897; Miczynski, 1886; Henry, 1884; Lamouroux, 1898, 1899.)

| t°. | Gms. $CH_2(COOH)_2$ per 100. Gms. Solution.* | cc. Solution (L.). |
|---|---|---|
| 0 | 52 | 61 |
| 10 | 56.5 | 67 |
| 20 | 60.5 | 73 |
| 25 | 62.2 | 76.3 |
| 30 | 64 | 80 |
| 40 | 68 | 86.5 |

| t°. | Gms. $CH_2(COOH)_2$ per 100. Gms. Solution.* | cc. Solution (L.). |
|---|---|---|
| 50 | 71 | 93 |
| 60 | 74.5 | 100 |
| 70 | ... | 106 |
| 80 | 82 | ... |
| 100 | 89 | ... |
| 132 m. pt. | 100 | ... |

* Average curve from results of K., M., and H.

100 gms. 95% formic acid dissolve 22.42 gms. malonic acid at 19.5°. (Aschan, 1913.)

10 cc cold saturated aqueous magnesium perchlorate solution dissolve about 3.8 gms. malonic acid. (Duclaux and Durand-Gasselin, 1938.)

100 gms. of benzene dissolve 0.0014 gm. malonic acid at 25°. (Verkade and Coops, Jr., 1930.)

### Solubility of Substituted Malonic Acids in Water.

(Lamouroux, 1899.)

| t°. | Gms. per 100 cc. Saturated Aqueous Solution. | | | | | |
|---|---|---|---|---|---|---|
| | Malonic Acid. | Methyl Malonic Acid. | Ethyl Malonic Acid. | *n* Propyl Malonic Acid. | *n* Butyl Malonic Acid. | Iso Amyl Malonic Acid. |
| 0 | 61.1 | 44.3 | 52.8 | 45.6 | 11.6 | 38.5 |
| 15 | 70.2 | 58.5 | 63.6 | 60.1 | 30.4 | 51.8 |
| 25 | 76.3 | 67.9 | 71.2 | 70 | 43.8 | 79.3 |
| 30 | 92.6 | 91.5 | 90.8 | 94.4 | 79.3 | 83.4 |

### Solubility of Malonic Acid in Aqueous Solutions of Dioxane at 25°.

(Herz and Lorentz, 1929.)

| Vol. Percent Dioxane in Solvent | Gm. Mols. $C_4H_4O_4$ per liter sat. sol. | Vol. Percent Dioxane in Solvent | Gm. Mols. $C_4H_4O_4$ per liter sat. sol. |
|---|---|---|---|
| 10 | 6.95 | 60 | 5.52 |
| 33 | 6.81 | 80 | 5.22 |
| 50 | 6.19 | 100 | 2.38 |

## MALONIC ACID $CH_2(COOH)_2$.

### Solubility of Malonic Acid at 25° in Aqueous Solutions of :

(Knox and Richards, 1919.)

#### Hydrochloric Acid.

| Equiv. normality of | |
|---|---|
| HCl. | $CH_2(COOH)_2$. |
| 0.0 | 15.01 |
| 4.443 | 7.70 |
| 6.210 | 5.99 |
| 8.658 | 4.71 |
| 10.47 | 4.32 |
| 11.09 | 4.26 |
| 11.22 | 4.30 |

#### Sulfuric Acid.

| Equiv. normality of | |
|---|---|
| $H_2SO_4$. | $CH_2(COOH)_2$. |
| 0.0 | 15.01 |
| 2.727 | 11.44 |
| 7.050 | 6.79 |
| 11.76 | 4.07 |
| 16.05 | 3.01 |
| 19.92 | 3.20 |
| 21.84 | 4.55 |

### Distribution of Malonic Acid at 25° Between : (Smith, 1921, 1922).

#### Water and Ethyl Ether.

| Millimols. $CH_2(COOH)_2$ per liter of | | |
|---|---|---|
| $H_2O$ layer ($C_1$). | $(C_2H_5)_2O$ layer ($C_2$). | $\frac{C_2}{C_1}$. |
| 2.1875 | 0.29375 | 0.134 |
| 3.80 | 0.5125 | 0.135 |
| 7.90 | 1.05 | 0.133 |
| 22.30 | 3.44 | 0.154 |
| 34.42 | 5.17 | 0.150 |
| 94.60 | 14.00 | 0.148 |

#### Acetone and Glycerol.

| Millimols. $CH_2(COOH)_2$ per liter of | | |
|---|---|---|
| Acetone layer (A). | Glycerol layer (G). | $\frac{A}{G}$. |
| 0.475 | 1.20 | 0.396 |
| 1.05 | 2.4875 | 0.423 |
| 1.8875 | 3.775 | 0.500 |
| 2.80 | 6.05 | 0.462 |
| 6.05 | 14.0 | 0.433 |

### The System Ethyl Ether–Malonic Acid–Water at 15°. (Klobbie, 1897.)

#### Results for Conjugated Liquid Layers Formed when Insufficient Malonic Acid to Saturate the Solutions Was Present.

| Gms. per 100 Gms. Lower Layer. | | | Gms. per 100 Gms. Upper Layer. | | |
|---|---|---|---|---|---|
| Malonic Acid. | $H_2O$. | Ethyl Ether. | Malonic Acid. | $H_2O$. | Ethyl Ether. |
| 0 | 92.23 | 7.77 | 0 | 1.20 | 98.80 |
| 4.63 | 87.42 | 7.94 | 0.72 | 1.54 | 97.74 |
| 11.60 | 79.92 | 8.48 | 2.19 | 1.99 | 95.82 |
| 20.45 | 69.55 | 9.99 | 5.01 | 3.08 | 91.91 |
| 27.43 | 60.57 | 12 | 9.52 | 5.19 | 85.29 |
| 33.63 | 47.45 | 18.80 | 21.89 | 13.42 | 64.91 |
| 34.17 | 35.81 | 30.02 | 30.44 | 25.37 | 44.19 |
| 31.11 | 26.76 | 42.12 | 31.11 | 26.76 | 42.12 |

#### Results for the Liquid Layers in Contact with Excess of Malonic Acid.

| Gms. per 100 Gms. Liquid. | | | Solid Phase. |
|---|---|---|---|
| Malonic Acid. | $H_2O$. | Ethyl. Ether. | |
| 8 | 0 | 92 | Malonic Acid |
| 9.96 | 0.42 | 89.61 | " |
| 19.41 | 2.79 | 77.80 | " |
| 27.22 | 5.23 | 67.54 | " |
| 35.51 | 10.73 | 53.75 | " |
| 46.48 | 20.86 | 32.66 | " |
| 51.33 | 26.30 | 22.36 | " |
| 57.37 | 39.10 | 3.52 | " |

## Distribution of Malonic Acid between Ether and Water at 25°.

(Chandler, 1908.)

| Mols. Acid per Liter. | | Coef. $\frac{\text{Conc. } H_2O}{\text{Conc. Ether}}$. | Dist. Coef. corrected for Ionization. |
|---|---|---|---|
| $H_2O$ Layer. | Ether Layer. | | |
| 0.1478 | 0.0135 | 10.94 | 9.86 |
| 0.1121 | 0.0102 | 11.07 | 9.79 |
| 0.0862 | 0.0076 | 11.28 | 9.86 |
| 0.0331 | 0.0027 | 12.22 | 9.82 |

## Distribution of Malonic Acid at 25° Between Water and:

(Kolossowsky and Bektourow, 1935; Kolossowsky, Kulikow and Bektourov, 1935.)

| Iso butyl alcohol $(CH_3)_2CHCH_2OH$ | | | Normal amyl alcohol $CH_3(CH_2)_3CH_2OH$ | | | Iso amyl alcohol $(CH_3)_2CHCH_2CH_2OH$ | | |
|---|---|---|---|---|---|---|---|---|
| Gm. equiv. $CH_2(COOH)_2$ per liter | | (1)/(2) | Gm. equiv. $CH_2(COOH)_2$ per liter | | (1)/(2) | Gm. equiv. $CH_2(COOH)_2$ per liter | | (1)/(2) |
| $H_2O$ layer (1) | Alcohol layer (2) | | $H_2O$ layer (1) | Alcohol layer (2) | | $H_2O$ layer (1) | Alcohol layer (2) | |
| 0.0178 | 0.0095 | 1.87 | 0.206 | 0.089 | 2.31 | 0.017 | 0.008 | 2.24 |
| 0.0356 | 0.0276 | 1.29 | 0.496 | 0.236 | 2.10 | 0.079 | 0.037 | 2.14 |
| 0.0755 | 0.0593 | 1.27 | 1.311 | 0.770 | 1.75 | 0.206 | 0.103 | 2.00 |
| 0.202 | 0.166 | 1.22 | 1.906 | 1.098 | 1.74 | 0.299 | 0.150 | 1.99 |
| 0.403 | 0.344 | 1.17 | 2.608 | 1.433 | 1.82 | 0.412 | 0.206 | 2.00 |
| 1.061 | 0.842 | 1.26 | 3.629 | 1.906 | 1.90 | 0.636 | 0.318 | 2.00 |
| 1.660 | 1.269 | 1.31 | 4.880 | 2.516 | 1.94 | 1.254 | 0.627 | 2.00 |
| 2.615 | 1.957 | 1.34 | 6.420 | 3.034 | 2.12 | 2.133 | 0.973 | 2.19 |
| 3.374 | 2.443 | 1.38 | 7.609 | 3.431 | 2.20 | 2.806 | 1.197 | 2.34 |
| 3.997 | 3.000 | 1.33 | 10.827 | 5.086 | 2.13 | 3.443 | 1.385 | 2.49 |
| 4.204 | 3.261 | 1.29 | 11.986 | 6.374 | 1.88 | 3.984 | 1.544 | 2.58 |

## Solubility of Malonic Acid in Alcohols.

(Timofeiew, 1894.)

| Alcohol. | t°. | Gms. $CH_2(COOH)_2$ per 100 Gms. Sat. Sol. |
|---|---|---|
| Methyl Alcohol | −18.5 | 42.7 |
| " " | −15 | 43.5 |
| " " | 0 | 47.3 |
| " " | +19 | 52.5 |
| " " | +19.5 | 53.3 |
| Ethyl Alcohol | −18.5 | 30 |
| " " | −15 | 30.7 |
| " " | 0 | 35.3 |
| " " | +19 | 40.1 |

| Alcohol. | t°. | Gms. $CH_2(COOH)_2$ per 100 Gms. Sat. Sol. |
|---|---|---|
| Ethyl Alcohol | +19.5 | 41.3 |
| Propyl Alcohol | −18.5 | 19.5 |
| " " | −15 | 20.2 |
| " " | 0 | 24.3 |
| " " | +19 | 29.5 |
| " " | +19.5 | 30.7 |
| Isobutyl Alcohol | 0 | 17.5 |
| " " | 19 | 21.2 |

## Solubility of Malonic Acid in Ether.

(Klobbie, 1897.)

| t°. | Gms. $CH_2(COOH)_2$ per 100 Gms. Solution. | t°. | Gms. $CH_2(COOH)_2$ per 100 Gms. Solution. | t°. | Gms. $CH_2(COOH)_2$ per 100 Gms. Solution. |
|---|---|---|---|---|---|
| 0 | 6.25 | 30 | 10.5 | 100 | 46 |
| 10 | 7.74 | 80 | 33 | 110 | 56 |
| 20 | 9 | 90 | 39 | 120 | 70 |
| 25 | 9.7 | | | 132 m. pt. | 100 |

100 gms. saturated solution of malonic acid in pyridine contain 14.6 gms. at 26°. (Holty, 1905.)

Sodium **MALONATES**

100 cc aq. 66.0 Vol. percent Ethyl Alcohol dissolve 5.44 gms. $HOOCCH_2COONa$
" " aq. 61.8 " " " " " 3.46 gms. $NaOOCCH_2COONa$
(McDermott, 1940.)

**ALLYLENE** $CH_3.CH:CH$

Freezing-point lowering data are given for mixture of $CH_3.CH:CH + HBr$ by Maas and Russel, 1921

**PROPIONITRILE** $C_2H_5CN$.

Solubility in Water.

Synthetic method used. See Note, p. 292. (Rothmund, 1898.)

| t° | Wt. per cent $C_2H_5CN$ in: Aq. Layer. | $C_2H_5CN$ Layer. | t°. | Wt. per cent $C_2H_5CN$ in: Aq. Layer. | $C_2H_5CN$ Layer. |
|---|---|---|---|---|---|
| 40 | 10.7 | 92.1 | 95 | 19.6 | 78.0 |
| 50 | 11.6 | 90.5 | 100 | 22.4 | 75.5 |
| 60 | 12.7 | 88.5 | 105 | 26.0 | 72.1 |
| 70 | 13.2 | 86.1 | 110 | 32.0 | 66.5 |
| 80 | 14.9 | 83.4 | 113.1 (crit. temp.) | 48.3 | |
| 90 | 17.6 | 80.2 | | | |

The freezing-points are given by Joukovsky, 1934, for mixtures of propionitrile and each of the following compounds: Acetonitrile, Butyronitrile, Valeronitrile and Benzene.

Results for mixtures of propio nitrile and cyclohexane are given by Hortenberg, 1926.

**EPICHLORHYDRIN** $O\begin{cases}CH.CH_2Cl\\CH_2\end{cases}$.

Reciprocal Solubility of Epichlorhydrin and Water. (Leoni and Benelli, 1922.)

Above 80° the epichlorhydrin begins to react with $H_2O$ and data cannot be obtained above this temperature.

$H_2O$ Rich Layer.

| t° | Gms. $C_3H_5OCl$ per 100 gms. sat. sol. |
|---|---|
| 30.2 | 6.60 |
| 52.0 | 7.53 |
| 65.0 | 8.45 |
| 72.0 | 9.34 |
| 80.2 | 10.47 |

Epichlorhydrin Rich Layer.

| t°. | Gms. $C_3H_5OCl$ per 100 gms. sat. sol |
|---|---|
| 25.0 | 98.48 |
| 45.0 | 97.43 |
| 70.0 | 95.82 |
| 80.4 | 94.17 |

α Bromo **PROPIONIC ACID** $CH_3CHBrCOOH$.

Distribution Between Acetone and Glycerol at 25°. (Smith, 1921, 1922.)

| Millimols. $C_2H_4BrCOOH$ per liter of: Acetone layer (A). | Glycerol layer (G). | $\frac{A}{G}$. |
|---|---|---|
| 1.42 | 0.21 | 6.75 |
| 2.62 | 0.30 | 8.73 |
| 4.50 | 0.40 | 11.2 |

| Millimols. $C_2H_4BrCOOH$ per liter of: Acetone layer (A). | Glycerol layer (G). | $\frac{A}{G}$. |
|---|---|---|
| 6.7625 | 0.4875 | 13.9 |
| 11.20 | 0.70 | 16.0 |
| 20.65 | 0.90 | 23.0 |

DISTRIBUTION OF α BROM PROPIONIC ACID AT 25° BETWEEN : (Smith, 1921, 1922.)

Water and Chloroform.

| Millimols. $C_2H_4BrCOOH$ per liter of | | |
|---|---|---|
| $H_2O$ layer ($C_1$). | $CHCl_3$ layer ($C_2$). | $\frac{C_2}{C_1}$. |
| 4.40 | 1.10 | 0.250 |
| 6.65 | 1.70 | 0.256 |
| 13.00 | 3.48 | 0.268 |
| 20.20 | 5.56 | 0.276 |

Water and Xylene.

| Millimols. $C_2H_4BrCOOH$ per liter of | | |
|---|---|---|
| $H_2O$ layer ($C_1$). | Xylene layer ($C_2$). | $\frac{C_2}{C_1}$. |
| 6.20 | 0.44 | 0.071 |
| 8.40 | 0.70 | 0.0835 |
| 10.50 | 1.000 | 0.095 |
| 13.10 | 1.40 | 0.107 |

Water and Ethyl Ether.

| Millimols. $C_2H_4BrCOOH$ per liter of | | |
|---|---|---|
| $H_2O$ layer ($C_1$). | $(C_2H_5)_2O$ layer ($C_2$). | $\frac{C_2}{C_1}$. |
| 0.3125 | 1.1250 | 3.60 |
| 0.40875 | 1.68125 | 4.02 |
| 0.5000 | 2.275 | 4.55 |
| 0.5875 | 2.7875 | 4.75 |
| 0.700 | 3.450 | 4.93 |

| Millimols. $C_2H_4BrCOOH$ per liter of | | |
|---|---|---|
| $H_2O$ layer ($C_1$). | $(C_2H_5)_2O$ layer ($C_2$). | $\frac{C_2}{C_1}$ |
| 0.8625 | 4.8625 | 5.64 |
| 1.125 | 6.675 | 5.93 |
| 1.300 | 9.5000 | 7.30 |
| 1.725 | 2.275 | 7.11 |

DISTRIBUTION OF α BROMO PROPRIONIC ACID AT 25° BETWEEN:
(Smith and White, 1929.)

Water and Chloroform

| Gm. Mols. $CH_3CHBrCOOH$ per liter of: | |
|---|---|
| $H_2O$ layer | $CHCl_3$ layer |
| 0.01222 | 0.00311 |
| 0.01606 | 0.00441 |
| 0.02122 | 0.00608 |
| 0.02781 | 0.00849 |
| 0.03539 | 0.01191 |
| 0.04248 | 0.01518 |
| 0.04810 | 0.01805 |

Water and Benzene

| Gm. Mols. $CH_3CHBrCOOH$ per liter of: | |
|---|---|
| $H_2O$ layer | $C_6H_6$ layerr |
| 0.01132 | 0.00192 |
| 0.01412 | 0.00254 |
| 0.01849 | 0.00352 |
| 0.02434 | 0.00507 |
| 0.02917 | 0.00638 |
| 0.03752 | 0.00910 |
| 0.04600 | 0.01180 |
| 0.06329 | 0.01856 |

Water and Toluene

| Gm. Mols. $CH_3CHBrCOOH$ per liter of: | |
|---|---|
| $H_2O$ layer | $C_6H_5CH_3$ layer |
| 0.01195 | 0.00137 |
| 0.01496 | 0.00180 |
| 0.01956 | 0.00255 |
| 0.02581 | 0.00360 |
| 0.03100 | 0.00455 |
| 0.04012 | 0.00690 |
| 0.04909 | 0.00871 |
| 0.06760 | 0.01425 |

β Bromo PROPIONIC ACID $CH_2BrCH_2COOH$.

DISTRIBUTION OF β BROMO PROPIONIC ACID AT 25° BETWEEN:
(Smith and White, 1929.)

Water and Chloroform

| Gm. Mols. $CH_2BrCH_2COOH$ per liter of: | |
|---|---|
| $H_2O$ layer | $CHCl_3$ layer |
| 0.00297 | 0.00063 |
| 0.00462 | 0.00108 |
| 0.00803 | 0.00185 |
| 0.01617 | 0.00456 |
| 0.02130 | 0.00633 |
| 0.02818 | 0.00862 |
| 0.04810 | 0.01845 |

Water and Benzene

| Gm. Mols. $CH_2BrCH_2COOH$ per liter of: | |
|---|---|
| $H_2O$ layer | $C_6H_6$ layer |
| 0.01520 | 0.00248 |
| 0.01881 | 0.00319 |
| 0.02203 | 0.00396 |
| 0.03201 | 0.00651 |
| 0.04840 | 0.01199 |
| 0.06280 | 0.01755 |
| 0.09170 | 0.03150 |

Water and Toluene

| Gm. Mols. $CH_2BrCH_2COOH$ per liter of: | |
|---|---|
| $H_2O$ layer | $C_6H_5CH_3$ layer |
| 0.01135 | 0.00126 |
| 0.01589 | 0.00179 |
| 0.02302 | 0.00297 |
| 0.03360 | 0.00492 |
| 0.05201 | 0.00838 |
| 0.06748 | 0.01287 |
| 0.09765 | 0.02355 |

### Distribution of α and of β Bromo Propionic Acid Between Water and Olive Oil.

(Bodansky, Meyer and Meigs, 1932.)

Results for α Bromo Propionic Acid

| t° | Gm. Mols. $C_3H_5BrO_2$ per liter: $H_2O$ layer (1) | Oil layer (2) | (1)/(2) |
|---|---|---|---|
| 25 | 0.031 | 0.0168 | 1.845 |
| " | 0.065 | 0.0364 | 1.785 |
| " | 0.125 | 0.067 | 1.87 |
| 37.5 | 0.069 | 0.032 | 2.155 |
| " | 0.136 | 0.065 | 2.09 |

Results for β Bromo Propionic Acid

| t° | Gm. Mols. $C_3H_5BrO_2$ per liter: $H_2O$ layer (1) | Oil layer (2) | (1)/(2) |
|---|---|---|---|
| 25 | 0.0338 | 0.017 | 1.99 |
| " | 0.0694 | 0.0326 | 2.13 |
| " | 0.140 | 0.066 | 2.12 |

## β Chloro PROPIONIC ACID $CH_2ClCH_2COOH$.

### Distribution of β Chloro Propionic Acid Between:

(Smith and White, 1929.)

| Water and Chloroform: Gm. Mols. $CH_2ClCH_2COOH$ per liter of: $H_2O$ layer | $CHCl_3$ layer | Water and Benzene: Gm. Mols. $CH_2ClCH_2COOH$ per liter of: $H_2O$ layer | $C_6H_6$ layer | Water and Toluene: Gm. Mols. $CH_2ClCH_2COOH$ per liter of: $H_2O$ layer | $C_6H_5CH_3$ layer |
|---|---|---|---|---|---|
| 0.01123 | 0.00156 | 0.01094 | 0.00096 | 0.01147 | 0.00069 |
| 0.01677 | 0.00250 | 0.01632 | 0.00152 | 0.01714 | 0.00111 |
| 0.01972 | 0.00308 | 0.01920 | 0.00183 | 0.02018 | 0.00134 |
| 0.02262 | 0.00354 | 0.02190 | 0.00213 | 0.02303 | 0.00157 |
| 0.02920 | 0.00480 | 0.02830 | 0.00296 | 0.02619 | 0.00185 |
| 0.04180 | 0.00778 | 0.04041 | 0.00459 | 0.04263 | 0.00348 |
| 0.05483 | 0.01120 | 0.05282 | 0.00661 | 0.05595 | 0.00504 |
| 0.08242 | 0.01958 | 0.07882 | 0.01159 | 0.08382 | 0.00934 |

### Distribution of β Chloro Propionic Acid Between Water and Olive Oil.

(Bodansky, Meyer and Meigs, 1932.)

Results at 25°

| Gm. Mols. $C_3H_5ClO_2$ per liter: $H_2O$ layer (1) | Oil layer (2) | (1)/(2) |
|---|---|---|
| 0.014 | 0.0032 | 4.56 |
| 0.074 | 0.0216 | 3.43 |
| 0.149 | 0.043 | 3.47 |

Results at 37.5°

| Gm. Mols. $C_3H_5ClO_2$ per liter: $H_2O$ layer (1) | Oil layer (2) | (1)/(2) |
|---|---|---|
| 0.0155 | 0.00314 | 4.94 |
| 0.0744 | 0.0206 | 3.61 |
| 0.153 | 0.038 | 4.03 |

## β Iodo PROPIONIC ACID $CH_2I.CH_2.COOH$.

One liter sat. solution in water contains 80 gms. $CH_2ICH_2COOH$ at 25°. (Sidgwick, 1910.)

One liter sat. solution in 1 n aq. sodium β iodopropionate contains 126 gms. at 25°. (Sidgwick, 1910.)

## β Iodo PROPIONIC ACID $CH_3CHICOOH$.

DISTRIBUTION OF β IODO PROPIONIC ACID AT 25° BETWEEN : (Smith, 1921, 1922.)

| Water and Chloroform. Millimols. $C_3H_5ICOOH$ per liter of | | | Water and Ether. Millimols. $C_3H_5ICOOH$ per liter of | | | Water and Xylene. Millimols $C_3H_5ICOOC_2H_5$ per liter of | | |
|---|---|---|---|---|---|---|---|---|
| $H_2O$ layer ($C_1$) | $CHCl_3$ layer ($C_2$). | $\frac{C_2}{C_1}$ | $H_2O$ layer ($C_1$). | $(C_2H_5)_2O$ layer ($C_2$) | $\frac{C_2}{C_1}$ | $H_2O$ layer ($C_1$). | Xylene layer ($C_2$). | $\frac{C_2}{C_1}$ |
| 1.162 | 0.5375 | 0.462 | 0.175 | 1.275 | 7.3 | 2.97 | 0.525 | 0.1765 |
| 1.61 | 0.805 | 0.500 | 0.280 | 2.26 | 8.1 | 3.90 | 0.745 | 0.191 |
| 2.80 | 1.541 | 0.552 | 0.500 | 4.64 | 9.3 | 6.60 | 1.44 | 0.218 |
| 3.70 | 2.12 | 0.572 | 0.900 | 8.66 | 9.6 | 7.25 | 1.75 | 0.242 |
| 5.55 | 3.50 | 0.630 | 1.44 | 15.22 | 10.6 | 13.75 | 4.46 | 0.325 |

## β Iodo PROPIONIC ACID.

DISTRIBUTION OF β IODO PROPIONIC ACID AT 25° BETWEEN:
(Smith and White, 1929.)

| Water and Chloroform. Gm. Mols. $CH_2ICH_2COOH$ per liter of: | | Water and Benzene. Gm. Mols. $CH_2ICH_2COOH$ per liter of: | | Water and Toluene. Gm. Mols. $CH_2ICH_2COOH$ per liter of: | |
|---|---|---|---|---|---|
| $H_2O$ layer | $CHCl_3$ layer | $H_2O$ layer | $C_6H_6$ layer | $H_2O$ layer | $C_6H_5CH_3$ layer |
| 0.000697 | 0.000274 | 0.00598 | 0.00217 | 0.00644 | 0.00177 |
| 0.00127 | 0.00056 | 0.00720 | 0.00278 | 0.00778 | 0.00226 |
| 0.00221 | 0.00096 | 0.00987 | 0.00424 | 0.01545 | 0.00592 |
| 0.00377 | 0.00208 | 0.01420 | 0.00717 | 0.02142 | 0.00992 |
| 0.00605 | 0.00366 | 0.01956 | 0.01178 | 0.02893 | 0.01612 |
| 0.01008 | 0.00727 | 0.02635 | 0.01870 | 0.03796 | 0.02542 |
| 0.01799 | 0.01650 | 0.03446 | 0.02892 | 0.05136 | 0.04290 |
| 0.03030 | 0.03575 | | | | |

## FORMYL GLYCINE $CH_2NH(COH)COOH$.

SOLUBILITY OF FORMYL GLYCINE IN AQUEOUS SOLUTIONS OF ETHYL ALCOHOL AT 25°
(McMeekin, Cohn and Weare, 1935.)

| Vol. Percent $C_2H_5OH$ in aq. solvent | d. of sat. sol. | Gm. Mols. $C_3H_5NO_3$ per liter | Vol. Percent $C_2H_5OH$ in aq. solvent | d. of sat. sol. | Gm. Mols. $C_3H_5NO_3$ per liter |
|---|---|---|---|---|---|
| 0.0 | 1.0570 | 1.849 | 70.0 | 0.9310 | 1.312 |
| 20.0 | 1.0402 | 1.680 | 80.0 | 0.8989 | 1.055 |
| 40.0 | 1.0078 | 1.633 | 90.0 | 0.8556 | 0.712 |
| 50.0 | 0.9824 | 1.560 | 100.0 | 0.8023 | 0.295 |
| 60.0 | 0.9572 | 1.459 | | | |

One liter of Methyl alcohol dissolves 0.710 gm. mol. $C_3H_7NO_3$ at 25° and the density of the solution is 0.8280. (McMeekin, Cohn and Weare, 1936.)
One liter of Heptyl alcohol dissolves 0.0347 gm. mol. $C_3H_5NO_3$ at 25° and the density of the solution is 0.82412. (McMeekin, Cohn and Weare, 1936.)

## GLYCEROL TRINITRATE (Nitroglycerin) $C_3H_5(O.NO_2)_3$

### Solubility of Nitroglycerin in Water.

(Ledbury and Frost, 1927.)

| t° | Gms. $C_3H_5(ONO_2)_3$ per 100 cc sat. sol. | t° | Gms. $C_3H_5(ONO_2)_3$ per 100 cc sat. sol. |
|---|---|---|---|
| 15 | 0.127 | 50 | 0.196 |
| 20 | 0.138 | 60 | 0.236 |
| 30 | 0.149 | 70 | 0.288 |
| 40 | 0.169 | 80 | 0.344 |

Appreciable hydrolysis occurs at 100°.

### Solubility of Trinitroglycerin and of Dinitroglycerin, in Aqueous Solutions of Nitric Acid and of Sodium Carbonate.

(Ohman, 1931.)

The results are given only in the form of diagrams from which the following values were taken. The temperature is not stated. The author also gives distribution and other results having reference to practical manufacturing conditions. The results show that losses in washing depend upon the content of dinitroglycerin in the trinitroglycerin phase.

Results for Aq. $HNO_3$ Solutions

| Gms. $HNO_3$ per 100 gms. solvent | Gms. per 100 gms. sat. sol. | |
|---|---|---|
| | Trinitro glycerin | Dinitro glycerin |
| 0.0 | 0.0 | 8.0 |
| 5.0 | 0.1 | 10.0 |
| 10.0 | 0.5 | 14.0 |
| 15.0 | 0.7 | 19.0 |
| 20.0 | 0.9 | 27.0 |
| 29.0 | 1.3 | — |

Results for Aq. $Na_2CO_3$ Solutions

| Gms. $Na_2CO_3$ per 100 gms. solvent | Gms. per 100 gms. sat. sol. | |
|---|---|---|
| | Trinitro glycerin | Dinitro glycerin |
| 0 | 0.1 | 7.8 |
| 2.0 | 0.05 | 6.3 |
| 4.0 | 0.001 | 5.1 |
| 6.0 | trace | 4.1 |
| 8.0 | " | 3.3 |
| 10.0 | " | 2.5 |

### Freezing-points of Mixtures of Glycerol Trinitrate and Toluene Trinitrate.

(Tamburrini, 1927.)

| t° | Gms. $C_3H_5(ONO_2)_3$ per 100 gms. mixture | t° | Gms. $C_3H_5(ONO_2)_3$ per 100 gms. mixture |
|---|---|---|---|
| 12.2-13.5 | 100 | 6.5-14.7 | 78 |
| 10.2-12.0 | 95 | 13.0-19.0 | 75 |
| 6.2- 9.8 | 88 | 21.0-22.0 | 70 |
| 6.5- 8.5 | 85 | 47.0-52.0 | 50 |
| 6.5- 7.1(Eutec) | 82.3 | 65.0-67.0 | 30 |
| 6.5-11.2 | 80 | 80.5-80.5 | 0 |

The temperatures are the beginning and end of fusion.

Freezing-point data are given by Kurita and Hagui, 1929, for mixtures of nitro glycerine with dinitro benzene and with trinitro toluene.

**PROPYLENE** $C_3H_6$.

SOLUBILITY IN WATER.
(Than, 1862.)

| t°. | β. | q. |
|---|---|---|
| 0 | 0.4465 | 0.0834 |
| 5 | 0.3493 | 0.06504 |
| 10 | 0.2796 | 0.0519 |
| 15 | 0.2366 | 0.0437 |
| 20 | 0.2205 | 0.0405 |

For values of $\beta$ and $q$, see Ethane, p. 126

1 cc. abs. ethyl alcohol dissolves from 12 to 13 cc. of propylene at 19°.
(Spörry, 1922, 1926.)

SOLUBILITY OF PROPYLENE IN SEVERAL SOLVENTS AT VARIOUS TEMPERATURES AND PRESSURES.
(Kirijew, Kaplan and Romantchouk, 1935.)

| Solvent | t° | cc. $C_3H_6$ (reduced to 0° and 760 mm.) dissolved by 1 cc solvent at: 50 | 100 | 200 | 300 | 400 | 500 | 600 | 700 | 760 mm Hg pressure |
|---|---|---|---|---|---|---|---|---|---|---|
| Kerosene | -21 | 3.0 | 5.5 | 10.5 | 15.5 | 21.0 | 27.5 | 35.0 | 42.1 | 76.1 |
| " | -10 | 2.5 | 4.5 | 8.5 | 13.0 | 17.0 | 21.5 | 26.0 | 30.5 | 33.0 |
| " | 0 | 2.0 | 3.0 | 6.0 | 9.0 | 12.0 | 15.0 | 18.0 | 21.0 | 23.0 |
| " | +20 | 1.0 | 1.8 | 3.0 | 5.0 | 7.0 | 8.5 | 10.3 | 12.0 | 13.8 |
| " | 40 | 0.8 | 1.0 | 2.0 | 3.0 | 4.5 | 5.5 | 6.5 | 7.8 | 8.5 |
| Xylene | -21 | 4.8 | 9.7 | 19.1 | 28.4 | 37.9 | 48.0 | 59.4 | 69.9 | 76.0 |
| " | -10 | 3.2 | 6.5 | 13.0 | 19.1 | 26.0 | 33.2 | 40.5 | 48.5 | 53.4 |
| " | 0 | 2.4 | 5.0 | 9.4 | 14.0 | 18.8 | 23.5 | 27.8 | 31.8 | 34.2 |
| " | +20 | 1.4 | 3.0 | 5.4 | 8.0 | 10.8 | 13.2 | 15.8 | 18.4 | 20.0 |
| " | 40 | 0.8 | 1.6 | 3.2 | 5.0 | 6.4 | 7.9 | 10.0 | 11.6 | 12.6 |
| Cracked benzin | -21 | 5.0 | 10.0 | 19.0 | 28.0 | 38.0 | 48.0 | 58.0 | 67.5 | 72.8 |
| " " | -10 | 4.0 | 7.0 | 13.0 | 19.0 | 26.0 | 32.5 | 38.5 | 44.0 | 47.4 |
| " " | 0 | 2.5 | 4.5 | 9.0 | 14.0 | 18.0 | 22.5 | 26.5 | 31.3 | 33.8 |
| " " | +20 | 1.5 | 3.0 | 5.0 | 8.0 | 10.0 | 12.0 | 14.0 | 16.0 | 17.2 |
| " " | 40 | 0.2 | 0.9 | 2.0 | 4.0 | 5.0 | 6.0 | 7.8 | 9.0 | 10.0 |
| Di chloro ethane | 0 | 2.8 | 3.6 | 7.1 | 10.6 | 14.1 | 17.3 | 20.2 | 23.2 | 25.2 |
| Light benzin fraction | 0 | 3.6 | 7.2 | 13.0 | 19.0 | 24.4 | 29.4 | 33.6 | 38.0 | 40.4 |
| Heavy benzin fraction | 0 | 1.4 | 2.8 | 7.8 | 9.4 | 13.3 | 17.1 | 21.6 | 25.7 | 28.2 |

**PROPYLENE BROMIDE** (1.3 Dibromo Propane) $CH_2BrCH_2CH_2Br$.

100 gms. $H_2O$ dissolve 0.168 gms. 1.3-$CH_2BrCH_2CH_2Br$ at 30° (Gross, Saylor and Gorman, 1933.)

**PROPYLENE BROMIDE** (1.2 Dibromo Propane) $CH_2BrCHBrCH_3$.

Freezing-point data for mixtures of Propylene Bromide and Ethylene bromide are given by Timmermans, 1934.)

**PROPYLENE CHLORIDE** (1.2 and 1.3 Dichloro Propane)

SOLUBILITY OF EACH SEPARATELY IN WATER AND IN AQUEOUS SALT SOLUTIONS AT 25°.

(Gross, 1929; 1929a.)

| Solvent | Gms. per 100 gms. $H_2O$ | |
|---|---|---|
| | 1.2, $CH_2ClCHClCH_3$ | 1.3, $CH_2ClCH_2CH_2Cl$ |
| Water | 0.280 | 0.273 (0.287 at 30° (1) |
| Aq. 0.5 n KCl solution | 0.241 | 0.230 |
| Aq. 0.5 n $MgSO_4$ solution | 0.160 | 0.158 |

(1) Gross, Saylor and Gorman, 1933.

**TETRA METHYL THIURAM SULFIDE** $(CH_3)_2NCS_2$.

Determinations of the solubility of tetra methyl thiuram sulfides (Sulfide, bis (dimethyl thio carbamyl) and other compounds, in rubber, by means of microscope examinations of prepared samples are described by Morris. 1932.

**PROPIONIC ALDEHYDE** $C_2H_5COH$.

100 gms. $H_2O$ dissolve 16 gms. aldehyde at 20°. (Vaubel, 1899.)

**ACETONE** $(CH_3)_2CO$.

SOLUBILITY OF ACETONE AT 25° IN AQUEOUS SOLUTIONS OF:

Electrolytes. Non-Electrolytes.

(Bell — J. Phys. Ch. 9, 544, 1905; Linebarger — Am. Ch. J. 14, 380, 1892.)

| Gms. Electrolyte per 100 Gms. Aq. Solution. | Gms. $(CH_3)_2CO$ per 100 Gms. Solvent in Solutions of: | | | | Gms. Non-Electrolyte per 100 Gms. Aq. Solution. | Gms. $(CH_3)_2CO$ per 100 Gms. Solvent in Solutions of: | | |
|---|---|---|---|---|---|---|---|---|
| | $K_2CO_3$ | $Na_2CO_3$ | $(NH_4)_2CO_3$ | $MgCO_3$ | | $C_{10}H_8$† | Anethol.* | $(C_6H_5)_2CO$. |
| 1.25 | ... | ... | ... | 83.5 | 5 | 92.5 | 103.0 | 90.0 |
| 2.50 | ... | 51.0 | 110.0 | 65.0 | 10 | 117.0 | 123.0 | 108.5 |
| 5.00 | 65.0 | 38.0 | 73.5 | 47.0 | 20 | 137.0 | 144.5 | 126.0 |
| 7.5 | 46.5 | 27.5 | 57.0 | 38.0 | 30 | 148.5 | 155.0 | 133.0 |
| 10.0 | 34.5 | 19.5 | 44.5 | 29.0 | 40 | 155.5 | 162.0 | 136.0 |
| 12.5 | 25.5 | 14.0 | 35.0 | ... | 50 | 159.5 | 166.0 | 135.5 |
| 15.0 | 18.0 | 9.0 | 28.0 | ... | 60 | 160.2 | 165.0 | 131.5 |
| 20.0 | 8.0 | 2.7 | ... | ... | 70 | 155.0 | 158.0 | 123.0 |
| 25.0 | 3.7 | ... | ... | ... | 80 | ... | ... | 108.5 |
| 30.0 | 1.6 | ... | ... | ... | 90 | ... | ... | 82.0 |

* Anethol = *p* Propenylanisol, $CH_3.CH:CH.C_6H_4OCH_3$. † Naphthalene results at 35°.

NOTE. — In the case of the results for the aqueous solutions of electrolytes, the determinations were made by adding successive small quantities of acetone to the mixtures of given amounts of water and electrolyte, and noting the point at which a clouding, due to the separation of a second phase, occurred. In the case of the aqueous non-electrolyte solutions, successive small amounts of water were added to mixtures of known amounts of acetone and the non-electrolyte. In all cases the results, as given in the original papers, have been recalculated and plotted on cross-section paper. From the curves so obtained, the above table was constructed.

Additional data for systems containing acetone are given under the salt involved, as, for instance, Potassium Carbonate, Potassium Fluoride, etc. (see VOL. I)

## Miscibility of Acetone at 0° with Mixtures of:

| Chloroform and Water (Bonner, 1910). | | | | Bromobenzene and Water (Bonner, 1910). | | | |
|---|---|---|---|---|---|---|---|
| Gms. $CHCl_3$. | Gms. $H_2O$. | Gms. $(CH_3)_2CO$. | Sp. Gr. of Mixture. | Gms. $C_6H_5Br$. | Gms. $H_2O$. | Gms. $(CH_3)_2CO$. | Sp. Gr. of Mixture. |
| 0.988 | 0.012 | 0.501 | 1.18 | 0.977 | 0.023 | 0.685 | 1.12 |
| 0.900 | 0.100 | 1.300 | 1.01 | 0.90 | 0.10 | 1.13 | 1.01 |
| 0.792 | 0.208 | 1.633 | 0.98 | 0.80 | 0.20 | 1.41 | 0.98 |
| 0.696 | 0.304 | 1.750 | 0.96 | 0.70 | 0.30 | 1.52 | 0.97 |
| 0.600 | 0.400 | 1.770 | 0.95 | 0.60 | 0.40 | 1.57 | 0.96 |
| 0.500 | 0.500 | 1.720 | 0.94 | 0.50 | 0.50 | 1.60 | 0.95 |
| *0.420 | 0.580 | 1.650 | ... | *0.49 | 0.51 | 1.60 | ... |
| 0.400 | 0.600 | 1.630 | 0.93 | 0.40 | 0.60 | 1.59 | 0.94 |
| 0.300 | 0.700 | 1.530 | 0.94 | 0.30 | 0.70 | 1.55 | 0.93 |
| 0.200 | 0.800 | 1.321 | 0.95 | 0.20 | 0.80 | 1.46 | 0.93 |
| 0.100 | 0.900 | 1.144 | 0.97 | 0.10 | 0.90 | 1.30 | 0.93 |
| 0.018 | 0.982 | 0.464 | 0.98 | 0.02 | 0.98 | 0.849 | 0.95 |

Note. — The determinations were made by gradually adding acetone to the mixtures of the given amounts of water and the other constituent until a homogeneous solution was obtained. The results give the binodal curve for the system. The author also determined "tie lines" showing the compositions of the various pairs of liquids which may exist in equilibrium. When the two layers are practically of the same composition the tie line is reduced to a point designated as the "plait point" of the binodal curve. This point is indicated by a * in the above tables.

## Solubility of Acetone in Aqueous Solutions of Carbohydrates.

(Krug and McElroy — J. Anal. Ch. 6, 184, '92; Bell — J. Phys. Ch. 9, 547, '05.)

### In Aqueous Solutions of Cane Sugar.

| Per cent Sugar. | Gms. $(CH_3)_2CO$ per 100 Gms. Sugar Solution at: | | | | | |
|---|---|---|---|---|---|---|
| | 15°. | 20°. | 25°. | 30°. | 35°. | 40°. |
| 10 | 597.2 | ... | 581.8 | ... | 574.8 | ... |
| 20 | 272.5 | ... | 250.0 | ... | 251.8 | ... |
| 30 | 172.4 | ... | 150.0 | ... | 150.6 | ... |
| 35 | ... | ... | ... | ... | ... | 110 |
| 40 | ... | 96.4 | 92.8 | 89.8 | ... | 85 |
| 45 | ... | 71.9 | 68.8 | 65.7 | ... | 62 |
| 50 | ... | 50.8 | 48.1 | 45.9 | ... | 42 |
| 55 | ... | 35.8 | 33.8 | 32.5 | ... | 29 |
| 60 | ... | 25.2 | 24.2 | 23.4 | ... | ... |
| 65 | ... | 18.3 | 17.7 | 17.0 | ... | ... |
| 70 | ... | 13.2 | 12.8 | 12.5 | ... | ... |

### In Aqueous Dextrose Solutions.

| Per cent Dextrose. | Gms. $(CH_3)_2CO$ per 100 Gms. Solvent at: | | |
|---|---|---|---|
| | 15°. | 25°. | 35°. |
| 10 | 736.7 | 747.9 | 761.5 |
| 20 | 255.3 | 247.7 | 240.8 |
| 30 | 157.5 | 149.8 | 142.5 |
| 40 | 86.9 | 79.6 | 74.0 |
| 50 | 36.2 | 33.0 | 31.2 |

### In Aqueous Maltose Solutions.

| Per cent Maltose. | Gms. $(CH_3)_2CO$ per 100 Gms. Solvent at: | | |
|---|---|---|---|
| | 15°. | 25°. | 35°. |
| 10 | 353.6 | 348.1 | 342.0 |
| 20 | 185.4 | 181.2 | 176.9 |
| 30 | 119.9 | 116.0 | 112.4 |
| 40 | 78.4 | 74.7 | 70.5 |
| 50 | 46.2 | 42.9 | 39.8 |

The determinations were made as in the case of the solubility of acetone in aqueous solutions of electrolytes. See preceding page.

### Miscibility of Acetone, *n* Butylalcohol and Water at 20°.
(Reilly and Ralph, 1919.)

Exceedingly great care was exercised in purifying the materials. The Acetone was of $d_{\frac{20}{4}} = 0{,}79091$ and b. pt. 56°-56°.5. The *n* Butylalcohol had $d_{\frac{20}{4}} = 0{,}80953$ and b. pt. 117°.6 at 760mm. The densities of a complete series of mixtures of weighed amounts of Acetone, *n* Butylalcohol and water were determined at $\frac{20}{4}$ and the results plotted. The miscibility limits for *n* Butylalcohol and water were determined by bringing mixtures of the two liquids to equilibrium in a thermostat at 20° and calculating the composition of each layer from its density. In order to determine the miscibility of the three components, acetone was added from a buret to a mixture of slightly more *n* Butylalcohol than required to saturate a given amount of water, untill the cloudy mixture just became clear. From the increase in weight the relative amounts of *n* Butylalcohol, acetone and water were calculated. A series of these determinations located the boundary curve of the system.

| Gms. per 100 gms. of mixture. | | | $d_{\frac{20}{4}}$. |
|---|---|---|---|
| *n* Butylalcohol. | Acetone. | Water. | |
| 7.90 | ..... | 92.10 | 0.9869 |
| 12.00 | 9.26 | 78.74 | 0.9670 |
| 18.64 | 11.62 | 69.74 | 0.9484 |
| 24.68 | 12.65 | 62.67 | 0.9340 |
| 28.15 | 12.95 | 58.90 | 0.9260 |
| 36.91 | 13.42 | 49.67 | 0.9071 |
| 47.02 | 13.10 | 39.88 | 0.8874 |
| 53.86 | 11.65 | 34.49 | 0.8764 |
| 63.68 | 8.28 | 28.04 | 0.8633 |
| 79.94 | ..... | 20.06 | 0.8477 |

The authors also determined the contraction on mixing, and give tables showing the densities and contraction of mixtures of acetone and water and of *n* Butylalcohol and water.

### Equilibrium in the Systems Acetone, Glycerol and Water and Acetone Glycerol and Acetic Anhydride at 20°.
(Ponomarev, 1938.)

Results for the binodal curve of:

Acetone, Glycerol and Water

| Gm. Mols. per 100 gms mols. homogeneous mixture | | |
|---|---|---|
| $(CH_3)_2CO$ | $C_3H_5(OH)_3$ | $H_2O$ |
| 64.0 | 13.5 | 22.5 |
| 54.5 | 13.7 | 31.8 |
| 40.1 | 16.8 | 43.1 |
| 25.7 | 26.1 | 48.2 |
| 16.7 | 40.4 | 42.9 |
| 14.5 | 53.9 | 31.6 |
| 14.8 | 62.8 | 22.4 |

Acetone, Glycerol and Acetic Anhydride

| Gm. Mols. per 100 gm. mols. homogeneous mixture | | |
|---|---|---|
| $(CH_3)_2CO$ | $C_3H_5(OH)_3$ | $(CH_3COO)_2O$ |
| 92.9 | — | 7.1 |
| 90.6 | 5.5 | 3.9 |
| 86.9 | 11.2 | 1.9 |
| 10.7 | — | 89.1 |
| 7.3 | 19.1 | 73.6 |
| 5.2 | 45.9 | 48.9 |
| 6.0 | 75.2 | 18.8 |

The author also determined the composition of the homogeneous layers formed in the quadruple system; Acetone, Glycerol, Acetic Anhydride and Water at 20°.

## Equilibrium in the System Acetone, Normal Butyl Alcohol and Water.

(Jones, 1929.)

Mixtures of n butyl alcohol and acetone were made up by weight and the solubility of each of these mixtures with water was determined by the synthetic method. These results were plotted and the isothermal (binodal) curves thus located. The author's curve for 20° agrees with the previous results of Reilly and Ralph, 1919. Results were also given showing the effect of impurities on the binary and ternary upper critical solution temperatures of the system.

| | Gms. per 100 gms. | | | | | |
|---|---|---|---|---|---|---|
| t° | Upper layer | | | Lower layer | | |
| | $H_2O$ | $(CH_3)_2CO$ | n $C_4H_{10}O$ | $H_2O$ | $(CH_3)_2CO$ | n $C_4H_{10}O$ |
| -15 | 19.1 | 0.0 | 80.9 | 87.9 | 0.0 | 12.1 |
| " | 24.0 | 6.9 | 69.10 | 86.0 | 1.27 | 12.73 |
| " | 34.9 | 11.71 | 53.39 | 83.9 | 2.90 | 13.20 |
| " | 54.0 | 13.63 | 32.37 | 82.2 | 5.27 | 12.53 |
| " | 64.1 | 13.54 | 22.36 | 80.5 | 7.35 | 12.5 |
| +25 | 20.16 | 0.0 | 79.84 | 93.8 | 0.0 | 6.2 |
| " | 25.0 | 6.8 | 68.2 | 92.1 | 0.72 | 7.18 |
| " | 36.2 | 11.48 | 52.32 | 90.85 | 1.65 | 7.50 |
| " | 55.45 | 13.20 | 31.35 | 88.87 | 3.30 | 7.83 |
| " | 69.0 | 1.69 | 19.31 | 86.52 | 5.08 | 8.40 |
| 50 | 22.53 | 0.0 | 77.47 | 94.0 | 0.0 | 6.6 |
| " | 27.6 | 6.57 | 65.83 | 92.4 | 0.69 | 6.91 |
| " | 38.45 | 11.08 | 50.47 | 91.4 | 1.55 | 7.05 |
| " | 58.8 | 12.21 | 28.99 | 89.24 | 3.19 | 7.57 |
| " | 58.8 | 12.21 | 28.99 | 89.24 | 3.19 | 7.57 |
| " | 74.02 | 9.80 | 16.18 | 86.68 | 5.02 | 8.30 |
| 75 | 26.30 | 0.0 | 73.79 | 93.78 | 0.0 | 6.22 |
| " | 32.40 | 6.13 | 61.47 | 92.18 | 0.71 | 7.10 |
| " | 42.75 | 10.30 | 46.95 | 90.8 | 1.66 | 7.54 |
| " | 71.01 | 8.59 | 20.40 | 86.81 | 3.91 | 9.28 |
| 100 | 33.60 | 0.0 | 66.4 | 91.33 | 0.0 | 8.67 |
| " | 43.5 | 5.12 | 51.38 | 89.05 | 0.99 | 9.96 |
| " | 71.57 | 5.12 | 23.31 | 84.64 | 2.76 | 12.60 |

## Equilibrium in the System Acetone, Furfural and Water at 25°.

(Lloyd, Thompson and Ferguson, 1937.)

The binodal curve was determined by titration, using a closed container provided with a side tube through which the liquids were introduced from a weight buret having a long fine delivery tip. Tie lines were determined by analysis for furfural of liquid layers prepared from weighed amounts of the constituents.

| Gms. per 100 gms. homogeneous mixture | | Gms. per 100 gms. homogeneous mixture | | Gms. per 100 gms. homogeneous mixture | |
|---|---|---|---|---|---|
| $(CH_3)_2CO$ | $C_4H_3OCHO$ | $(CH_3)_2CO$ | $C_4H_3OCHO$ | $(CH_3)_2CO$ | $C_4H_3OCHO$ |
| 0 | 7.7 | — | 16.0(3) | — | 64.0(3) |
| 2.2 | 8.5 | — | 21.0(4) | 19.3 | 70.1 |
| 4.7 | 9.3 | 24.1 | 23.4 | — | 74.5(2) |
| — | 10.0(1) | 27.4 | 35.8 PP | 10.6 | 81.6 |
| 9.4 | 10.5 | 28.0 | 47.8 | — | 84.0(1) |
| — | 12.2(2) | — | 53.5(4) | 4.0 | 90.3 |
| 17.9 | 15.1 | 25.8 | 57.7 | 0.0 | 94.7 |

(1)(2)(3) & (4) Furfural content of liquid layers in contact with each other. PP is the plait point.

## Equilibrium in the System Acetone, Benzene and Water at 20°.

(Bancroft, 1895.)

Water was added to mixtures of known amounts of the other two liquids until clouding appeared.

| Per 5 cc $(CH_3)_2CO$ | | Per 5 cc $(CH_3)_2CO$ | |
|---|---|---|---|
| cc $H_2O$ | cc $C_6H_6$ | cc $H_2O$ | cc $C_6H_6$ |
| 8.0 | 0.10 | 0.51 | 2.0 |
| 3.0 | 0.395 | 0.295 | 3.0 |
| 2.0 | 0.69 | 0.2 | 4.0 |
| 1.3 | 1.0 | 0.15 | 5.0 |

## The Ternary System Acetone, Toluene and Water.

(Walton and Jenkins, 1923.)

Definite amounts of water and toluene were mechanically stirred at constant temperature and acetone slowly added untill the mixture just cleared. The volumes of the liquids were read from burets. A series of such determinations gave the equilibrium line between the one-liquid phase and the two-liquid phase systems.

| Results at 0° : Gms. per 100 gms. sat. sol. | | | Results at 20° : Gms. per 100 gms. sat. sol. | | | Results at 30° : Gms. per 100 gms. sat. sol. | | |
|---|---|---|---|---|---|---|---|---|
| Water. | Toluene. | Acetone. | Water. | Toluene. | Acetone. | Water | Toluene. | Acetone |
| 0.5 | 70.3 | 29.2 | 0.5 | 76.0 | 23.5 | 1.5 | 61.5 | 37.0 |
| 1.0 | 60.0 | 39.0 | 1.0 | 68.9 | 33.1 | 2.0 | 56.1 | 41.9 |
| 1.5 | 53.3 | 45.2 | 1.5 | 58.5 | 40.0 | 2.5 | 51.6 | 45.9 |
| 2.0 | 48.6 | 49.4 | 2.0 | 53.6 | 44.4 | 3.0 | 48.5 | 48.5 |
| 2.5 | 44.4 | 52.6 | 2.5 | 49.4 | 48.1 | 4.0 | 43.1 | 52.9 |
| 3.0 | 41.6 | 55.4 | 3.0 | 45.9 | 51.1 | 5.0 | 38.6 | 56.4 |
| 4.0 | 36.8 | 59.2 | 4.0 | 40.6 | 55.4 | 7.0 | 32.3 | 60.7 |
| 5.0 | 33.2 | 61.8 | 5.0 | 36.6 | 58.4 | 10.0 | 26.0 | 64.0 |
| 7.0 | 28.1 | 64.9 | 7.0 | 30.6 | 62.4 | 15.0 | 19.7 | 65.3 |
| 10.0 | 23.0 | 67.0 | 10.0 | 25.0 | 65.0 | 14.6 | 20.1 | 65.3* |
| 13.0 | 19.4 | 67.6* | 14.2 | 19.8 | 66.0* | 20.0 | 15.5 | 64.5 |
| 15.0 | 17.5 | 67.5 | 15.0 | 19.0 | 66.0 | 25.0 | 12.2 | 62.8 |
| 20.0 | 13.6 | 66.4 | 20.0 | 14.9 | 65.1 | 28.7 | 10.0 | 61.3 |
| 25.0 | 10.0 | 64.9 | 25.0 | 11.5 | 63.5 | 34.3 | 7.0 | 58.7 |
| 30.0 | 7.1 | 62.9 | 30.0 | 8.5 | 61.5 | 39.0 | 5.0 | 56.0 |
| 34.6 | 5.0 | 60.4 | 35.0 | 6.0 | 59.0 | 42.1 | 4.0 | 53.9 |
| 37.4 | 4.0 | 58.8 | 37.6 | 5.0 | 57.4 | 46.0 | 3.0 | 51.0 |
| 41.0 | 3.0 | 56.0 | 40.5 | 4.0 | 55.5 | 50.8 | 2.0 | 47.2 |
| 45.6 | 2.0 | 52.4 | 43.8 | 3.0 | 53.2 | 54.4 | 1.5 | 44.1 |
| 48.8 | 1.5 | 49.7 | 48.3 | 2.0 | 49.7 | 59.4 | 1.0 | 39.6 |
| 53.5 | 1.0 | 45.5 | 57.0 | 1.0 | 42.0 | 68.3 | 0.5 | 31.2 |
| 61.0 | 0.5 | 38.5 | 65.0 | 0.5 | 34.3 | 71.5 | 0.4 | 28.1 |

* Maximum.

## Mutual Solubility of Acetone and Glycerol. (Mc Ewen, 1923.)

The synthetic method of Alexejeff was used. The temperatures at which separation of liquid phases occurred in mixtures of known amounts of acetone and glycerol were determined.

| t°. | Wt. per cent of Acetone. | t°. | Wt. per cent of Acetone. | t°. | Wt. per cent of Acetone. | t°. | Wt per cent of Acetone. |
|---|---|---|---|---|---|---|---|
| 9.5... | 10.90 | 90.9... | 34.74 | 95.6*.. | 51.28 | 93.5... | 64.47 |
| 44.8... | 15.77 | 95.2... | 44.67 | 95.7... | 53,07 | 91.7... | 67.42 |
| 66.6... | 20.40 | 95.3... | 45.75 | 95.6*.. | 55.34 | 81.3... | 76.96 |
| 81.3... | 26.58 | 95.3*.. | 46.31 | 95.5... | 56.59 | 58.5... | 86.93 |
| 85,3... | 29.24 | 95.5*.. | 48.43 | 95.5... | 57.25 | 49.0 .. | 89.61 |

* Indicates critical opalescence.

The critical temp. of solution of the system Acetone + Diisoamylene is at — 3°.8 and the mixture contains 52.5 per cent $C_{10}H_{20}[(CH_3)_2CHCH_2CH_2]_2$. (Hartenberg, 1926.)

## Distribution of Acetone between:

(Herz and Rathmann, 1913)

### Water and Carbon Tetrachloride.

Mols. $(CH_3)_2CO$ per Liter.

| $H_2O$ Layer. | $CCl_4$ Layer. |
|---|---|
| 0.186 | 0.0833 |
| 0.322 | 0.146 |
| 1.01 | 0.514 |
| 1.66 | 0.997 |
| 2.87 | 2.10 |
| ... | ... |

### Water and Chloroform.

Mols. $(CH_3)_2CO$ per Liter.

| $H_2O$ Layer. | $CHCl_3$ Layer. |
|---|---|
| 0.032 | 0.168 |
| 0.0781 | 0.399 |
| 0.145 | 0.676 |
| 0.263 | 1.17 |
| 0.493 | 1.98 |
| 1.01 | 3.06 |

### Water and Pentachlorethane.

Mols. $(CH_3)_2CO$ per Liter.

| $H_2O$ Layer. | $C_2HCl_5$ Layer. |
|---|---|
| 0.144 | 0.251 |
| 0.271 | 0.469 |
| 0.541 | 0.859 |
| 0.806 | 1.275 |
| 1.149 | 1.763 |
| ... | ... |

### Water and Tetrachlorethane.

Mols. $(CH_3)_2CO$ per Liter.

| $H_2O$ Layer. | $C_2H_2Cl_4$ Layer. |
|---|---|
| 0.0812 | 0.341 |
| 0.249 | 0.994 |
| 0.317 | 1.210 |
| 0.363 | 1.323 |
| 0.569 | 1.936 |

### Water and Tetrachlorethylene.

Mols. $(CH_3)_2CO$ per Liter.

| $H_2O$ Layer. | $CCl_2:CCl_2$ Layer. |
|---|---|
| 0.274 | 0.081 |
| 0.562 | 0.174 |
| 1.020 | 0.343 |
| 1.545 | 0.629 |
| 2.007 | 0.891 |

### Water and Trichlorethylene.

Mols. $(CH_3)_2CO$ per Liter.

| $H_2O$ Layer. | $CHCl:CCl_2$ Layer. |
|---|---|
| 0.160 | 0.193 |
| 0.350 | 0.359 |
| 0.654 | 0.719 |
| 0.946 | 1.029 |
| 1.389 | 1.562 |

The distribution coefficient of acetone between olive oil and water is given by Meyer (1901), as 0.146 at 3° and 0.235 at 30°.

## Distribution of Acetone Between Water and Chloroform at 25°.

(Hand, 1930.)

Suitable quantities of the three liquids to yield two layers were mixed and brought to equilibrium at 25°. Samples of each layer were withdrawn with extreme care and analyzed for chloroform and acetone.

Grams per 100 gms.

| Upper Layer | | | Lower Layer | | |
|---|---|---|---|---|---|
| $CHCl_3$ | $H_2O$ | $(CH_3)_2CO$ | $CHCl_3$ | $H_2O$ | $(CH_3)CO$ |
| 1.23 | 82.97 | 15.8 | 70.0 | 1.3 | 28.7 |
| 1.29 | 73.11 | 25.6 | 55.7 | 2.2 | 42.1 |
| 1.71 | 62.29 | 36.0 | 42.9 | 4.4 | 52.7 |
| 3.20 | 54.1 | 42.7 | 35.8 | 7.7 | 56.5 |
| 5.1 | 45.6 | 49.3 | 28.4 | 10.3 | 61.3 |
| 9.8 | 34.5 | 55.7 | 20.4 | 18.6 | 61.0 |

## Distribution of Acetone Between Water and Methyl Alcohol Separated by a Rubber Membrane at 23°.

(Morton, 1929.)

| Gms. $(CH_3)_2CO$ per 100 gms. | | (2)/(1) | Gms. $(CH_3)_2CO$ per 100 gms. | | (2)/(1) |
|---|---|---|---|---|---|
| $H_2O$ layer(1) | $CH_3OH$ layer(2) | | $H_2O$ layer | $CH_3OH$ layer(2) | |
| 10 | 17(16.1 | 1.7 | 50 | 69.5(69.9) | 1.39 |
| 20 | 32(30.5) | 1.6 | 60 | 77.5(76.2) | 1.29 |
| 30 | 46(46.6) | 1.53 | 70 | 85 (81.4) | 1.21 |
| 40 | 59(59.4) | 1.47 | 100 | 100 | 1.00 |

The values in parentheses were calculated from the vapor pressure.

## Distribution of Acetone between:

### Benzene and Water.

Results at 20°. (Philip and Bramby, 1915.) Gm. $(CH_3)_2CO$ per 1000 cc.

| $H_2O$ Layer. | $C_6H_6$ Layer. |
|---|---|
| 0.10 | 0.08 |
| 0.20 | 0.12 |
| 0.30 | 0.25 |
| 0.40 | 0.34 |
| ... | ... |

Results at 25°. (Herz and Fischer, 1905.) Gms. $(CH_3)_2CO$ per 1000 cc.

| $H_2O$ Layer. | $C_6H_6$ Layer. |
|---|---|
| 10* | 12.0 |
| 50 | 41.7 |
| 100 | 101.5 |
| 150 | 155.9 |
| 200 | 225.0 |

### Toluene and Water. At Different Temps.

(Hantzsch and Vagt, 1901.) Gms. $(CH_3)_2CO$ per 1000 cc.

| t°. | $H_2O$ Layer. | $C_6H_5CH_3$ Layer. |
|---|---|---|
| 0 | 2.105 | 0.993 |
| 10 | 2.000 | 0.957 |
| 20 | 1.960 | 0.957 |
| 30 | 1.867 | 0.957 |
| ... | ... | ... |

* See Note, page 106

Philip and Bramby also give data for the effect of NaCl, KCl and LiCl upon the distribution of acetone between benzene and water.

In the determinations by Hantzsch and Vagt the equilibrium was approached from above. The amount of acetone in the lower layer was determined by analysis, and that in the upper layer calculated by difference.

## Distribution of Acetone Between Water and Benzene.

(Gross and Schwarz, 1930.)

Results at 15°

| Gm. Mols. $(CH_3)_2CO$ per liter | | (2)/(1) |
|---|---|---|
| $H_2O$ layer(1) | $C_6H_6$ layer($C_2$) | |
| 0.02267 | 0.01740 | 0.767 |
| 0.02302 | 0.01768 | 0.768 |
| 0.02306 | 0.01768 | 0.766 |
| 0.1140 | 0.0887 | 0.778 |

Results at 25°

| Gm. Mols. $(CH_3)_2CO$ per liter | | (2)/(1) |
|---|---|---|
| $H_2O$ layer(1) | $C_6H_6$ layer (2) | |
| 0.01583 | 0.01437 | 0.898 |
| 0.03209 | 0.02898 | 0.901 |
| 0.08007 | 0.0726 | 0.907 |
| 0.1058 | 0.09659 | 0.912 |
| 0.3125 | 0.2909 | 0.931 |
| 0.6150 | 0.5940 | 0.966 |
| 0.904 | 0.906 | 1.002 |

## Distribution of Acetone Between Aqueous Potassium Chloride and Benzene at 15°.

(Gross and Schwarz, 1930.)

| Gm. Mols. KCl per liter aq. sol. | Gm. Mols. $(CH_3)_2CO$ per liter | | (2)/(1) |
|---|---|---|---|
| | Aq. layer(1) | $C_6H_6$ layer(2) | |
| 0.5 | 0.02181 | 0.01883 | 1.158 |
| 1.0 | 0.02068 | 0.02002 | 1.033 |
| 1.5 | 0.01947 | 0.02119 | 0.919 |
| 2.0 | 0.01824 | 0.02232 | 0.817 |

The authors also give results for a number of other aqueous salt solutions. It is concluded that the salting out effect depends upon the nature of the substances to be salted out and little upon the concentration and temperature. It is also dependant upon the nature of the salt and is roughly proportional to the concentration of the salt solution.

## Distribution of Acetone Between Water and Benzene and Between Aqueous Salt Solutions and Benzene at 25°.

(Herz and Stanner, 1927.)

| Normality of aq. salt sol. | Gm. Mols. $(CH_3)_2CO$ per liter: Aq. layer(1) | $C_6H_6$ layer(2) | (2)/(1) | Normality of aq. salt sol. | Gm. Mols. $(CH_3)_2CO$ per liter: Aq. layer(1) | $C_6H_6$ layer(2) | (2)/(1) |
|---|---|---|---|---|---|---|---|
| Water alone | 0.262 | 0.245 | 0.93 | 2.956 NaCl | 0.168 | 0.336 | 2.00 |
| " " | 0.493 | 0.481 | 0.97 | 2.951 " | 0.331 | 0.663 | 2.00 |
| " " | 0.587 | 0.581 | 0.99 | 2.941 " | 0.486 | 0.989 | 2.04 |
| " " | 0.658 | 0.706 | 1.07 | 2.887 " | 0.589 | 1.252 | 2.12 |
| " " | 1.372 | 1.433 | 1.04 | 2.988 NaBr | 0.207 | 0.301 | 1.46 |
| 2.978 LiCl | 0.172 | 0.250 | 1.45 | 2.910 " | 0.415 | 0.615 | 1.48 |
| 2.922 " | 0.396 | 0.611 | 1.54 | 2.949 " | 0.581 | 0.897 | 1.54 |
| 2.899 " | 0.611 | 0.946 | 1.55 | 2.890 " | 0.757 | 1.235 | 1.63 |
| 2.854 " | 0.731 | 1.144 | 1.57 | | | | |

## Distribution of Acetone Between Water and Aniline at 30°.

(Campbell and Broun, 1933.)

| Gms. per 100 gms. Aqueous Layer: $C_6H_5NH_2$ | $(CH_3)_2CO$ | $H_2O$ | Aniline Layer: $C_6H_6NH_2$ | $(CH_3)_2CO$ | $H_2O$ |
|---|---|---|---|---|---|
| 3.35 | 0.0 | 96.65 | 95.25 | 0.0 | 4.75 |
| 3.81 | 0.422 | 95.767 | 91.5 | 3.68 | 4.82 |
| 3.964 | 0.906 | 95.13 | 90.04 | 4.509 | 5.451 |
| 4.15 | 2.64 | 93.21 | 83.19 | 9.735 | 7.075 |
| 3.85 | 7.08 | 89.07 | 72.66 | 5.5 | 11.85 |
| 4.105 | 9.57 | 86.325 | 65.5 | 25.15 | 9.35 |
| 4.27 | 12.78 | 82.95 | 59.39 | 30.03 | 10.58 |
| 6.1 | 21.03 | 72.87 | 48.32 | 37.48 | 14.2 |
| 8.78 | 25.11 | 66.11 | 40.13 | 39.45 | 20.42 |
| 12.95 | 31.56 | 55.42 | 28.83 | 40.5 | 30.67 |
| 21.1 | 36.6 | 42.3 | 21.1 | 36.6 | 42.3* |

* Critical composition

The authors also give the following determinations of the temperature of homogeneity of mixtures of the three liquids contained in sealed hard glass tubes.

| t° | Gms. per 100 gms. Homogeneous mixture: $C_6H_5NH_2$ | $(CH_3)_2CO$ | $H_2O$ | t° | Gms. per 100 gms. Homogeneous mixture: $C_6H_5NH_2$ | $(CH_3)_2CO$ | $H_2O$ |
|---|---|---|---|---|---|---|---|
| 86 | 21.0 | 31.68 | 47.32 | 136 | 71.54 | 7.92 | 20.5 |
| 92 | 71.54 | 15.84 | 12.62 | 156 | 48.6 | 5.0 | 46.4 |
| 101 | 30.0 | 25.00 | 45.0 | 159 | 71.54 | 7.92 | 20.5 |
| 104.5 | 48.6 | 31.68 | 19.72 | 166.5 | 48.6 | 1.4 | 50.0 |
| 122 | 21.0 | 15.84 | 63.16 | | | | |

## Reciprocal Solubility of Acetone and Carbon Disulfide.

(Wieth, 1929.)

| t° | Gms. $(CH_3)_2CO$ per 100 gms. mixture | t° | Gms. $(CH_3)_2CO$ per 100 gms. mixture |
|---|---|---|---|
| -55 | 14.8 | -43.5 | 51.4 |
| -45 | 28.7 | -52 | 61.8 |
| -42.5 | 41.2 | -72 | 78.4 |
| -42.5 | 46.0 | | |

## Reciprocal Solubility of Acetone and Chloroform.

(Wyatt, 1928.)

The results are given only in the form of a diagram from which the following approximated values were read.

| t° | Gm. Mol. $(CH_3)_2CO$ per 100 gm. mols. mixture | Solid Phase | t° | Gm. Mols. $(CH_3)_2CO$ per 100 gm. mols. mixture | Solid Phase |
|---|---|---|---|---|---|
| - 96 | 100 | $(CH_3)_2CO$ | -105 | 45.0 | $(CH_3)_2CO.CHCl_3$ |
| -110 | 79 | " | -117 | 38.0 | " + $CHCl_3$ |
| -117 Eutec | 73 | " + $(CH_3)_2CO.CHCl_3$ | -100 | 34.0 | $CHCl_3$ |
| -110 | 66.5 | $(CH_3)_2CO.CHCl_3$ | - 80 | 23.0 | " |
| - 99.5m.pt. | 50 | " | - 62 | 0.0 | " |

## Reciprocal Solubility of Acetone and Ethyl Ether.

(Saphir, 1929.)

| t° | Wt. Percent $(CH_3)_2CO$ | Mol. Percent $(CH_3)_2CO$ | t° | Wt. Percent $(CH_3)_2CO$ | Mol. Percent $(CH_3)_2CO$ |
|---|---|---|---|---|---|
| - 95.6 | 100 | 100 | -127.5 Eutec | — | — |
| -102.7 | 81.1 | 84.6 | -125.5 | 11.0 | 13.6 |
| -109.2 | 60.8 | 66.4 | -123.4 | 0.0 | 0.0 |
| -116.8 | 39.2 | 45.1 | | | |

## Reciprocal Solubility of Acetone and Benzene.

(Yamamura, 1926.)

| t° | Mol. Percent $(CH_3)_2CO$ | Solid Phase | t° | Mol. Percent $(CH_3)_2CO$ | Solid Phase |
|---|---|---|---|---|---|
| -94.8 | 100 | $(CH_3)_2CO$ | -40 | 69.1 | $C_6H_6$ |
| -96 | 96.6 | " | -25 | 52.0 | " |
| -98 Eutec. | — | " | -15 | 38.4 | " |
| -87 | 89.9 | $C_6H_6$ | - 5 | 21.3 | " |
| -72 | 86.0 | " | + 5.1 | 0.0 | |

Freezing-point data are also given for:

| | | |
|---|---|---|
| $(CH_3)_2CO$ + | $CCl_4$ | (Timmermans, 1928; Wyatt, 1929.) |
| | + $CH_3OH$ | (Sapgir, 1929.) |
| | + $C_2H_5OH$ | " " |
| | + $C_5H_{12}$ (iso pentane) | " " |
| | + $C_6H_5NH_2$ | (Timmermans, 1928.) |
| | + $CHCl_3$ | (Tskalotos, and Guye, 1910.) |
| " | + o $C_6H_4ClOH$ | (Bramby, 1916.) |
| " | + Phenol | (Schmidlin and Lang, 1910.) |
| " | + Resorcinol | " " " " |
| " | + Pyrogallol | " " " " |
| " | + Pyrocatechol | " " " " |

Freezing-point data for mixtures of Dianisol acetone, Dibenzyl acetone, Tetra methyl diamido dibenzyl acetone and Cinnamyliden benzal acetone, each with a series of other compounds, are given by Pfeiffer, 1924, and Pfeiffer and Angern, 1926.

**ETHYL FORMATE** $HCOOC_2H_5$.

100 grams water dissolve 10 grams ethyl formate at 22°. (Traube, 1884.)

100 grams water dissolve 10 grams ethyl formate at 22°. (Traube, 1884.)

RECIPROCAL SOLUBILITY OF ETHYL FORMATE AND WATER.
(Kendall and Harrison, 1928.)

The determinations were made by the synthetic, sealed tube method.

| t° | Mol. Percent $HCOOC_2H_5$ in sat. sol. | t° | Mol. Percent $HCOOC_2H_5$ in sat. sol. | t° | Mol. Percent $HCOOC_2H_5$ in sat. sol. |
|---|---|---|---|---|---|
| 5.0 | 1.97 | 38.0 | 2.23 | 55.5 | 2.49 |
| 15.9 | 2.05 | 45.1 | 2.31 | 63.9 | 2.73 |
| 30.2 | 2.15 | 50 | 2.41 | 70.0 | 2.95 |
| | | | | 75.5 | 3.20 |

The authors also give the following determinations of the depression of the freezing-point of water + ethyl formate mixtures.

| t° of freezing | Mol. Percent $HCOOC_2H_5$ in mixture | t° of freezing | Mol. Percent $HCOOC_2H_5$ in mixture | t° of freezing | Mol. Percent $HCOOC_2H_5$ in mixture |
|---|---|---|---|---|---|
| -0.132 | 0.119 | -0.569 | 0.507 | -1.082 | 0.976 |
| -0.184 | 0.164 | -0.837 | 0.757 | -1.847 | 1.638 |
| -0.343 | 0.311 | -0.859 | 1.768 | -2.203 | 1.901 |
| -0.404 | 0.354 | -0.941 | 0.841 | | |

FREEZING-POINTS OF MIXTURES OF ETHYL FORMATE AND TIN TETRACHLORIDE.
(Kournakov, Perelmouter and Kanov, 1916.)

| t°. | Mol. per cent $SnCl_4$. | t°. | Mol. per cent $SnCl_4$. | t°. | Mol. per cent $SnCl_4$. |
|---|---|---|---|---|---|
| —10..... | 10.0 | 48.6 ..... | 33.7 | 28.0..... | 58.0 |
| +15..... | 20.0 | 47.1..... | 36.0 | 24.0..... | 65.0 |
| 33.5..... | 25.9 | 45.5... .... | 38.3 | 20.0..... | 73.0 |
| 46.0..... | 30.5 | 44.0..... | 40.0 | 16.0..... | 80.0 |
| 48.0..... | 31.8 | 38.2..... .. | 46.0 | 10.0..... | 90.0 |
| 49.0(m.pt.). | 33.3 | 32.7..... | 52.0 | —33.0..... | 100.0 |

The above results give the curve for the molecular compound $SnCl_4.2HCOO(C_2H_5)$.

The freezing-points of Ethyl formate + Ethyl propionate are given by Timmermans, 1934.

**METHYL ACETATE** $CH_3COOCH_3$.

SOLUBILITY OF METHYL ACETATE IN WATER.

| t° | Gms. $CH_3COOCH_3$ per 100 gms. $H_2O$ | Authority |
|---|---|---|
| 20 | 32.19 | (Führer, 1924.) |
| 22 | 25 | (Traube, 1884.) |

100 gms. 0.4 n Aq. Sodium Oleate Solution (= 10.8 gms. Na oleate per 100 gms. sol.) dissolve 71.0 gms. $CH_3COOCH_3$ at 20°. (Smith, 1932.)

## METHYL ACETATE

### Reciprocal Solubility of Methyl Acetate and Water.

(Kendall and Harrison, 1928.)

The determinations were made by the synthetic (sealed tube) method.

| t° | Mol. Percent $CH_3COOCH_3$ in sat. sol. | t° | Mol. Percent $CH_3COOCH_3$ in sat. sol. | t° | Mol. Percent $CH_3COOCH_3$ in sat. sol. |
|---|---|---|---|---|---|
| 5.0 | 6.62 | 58.0 | 7.00 | 70.5 | 7.66 |
| 21.0 | 6.70 | 61.7 | 7.11 | 71.9 | 7.73 |
| 35.0 | 6.79 | 69.1 | 7.51 | 83.5 | 8.83 |

These authors also give the following determinations of the depression of the freezing-point of water + methyl acetate mixtures.

| t° of freezing | Mol. Percent $CH_3COOCH_3$ in mixture | t° of freezing | Mol. Percent $CH_3COOCH_3$ in mixture | t° of freezing | Mol. Percent $CH_3COOCH_3$ in mixture |
|---|---|---|---|---|---|
| -0.096 | 0.097 | -0.355 | 0.373 | -1.523 | 1.476 |
| -0.139 | 0.157 | -0.562 | 0.562 | -1.758 | 1.703 |
| -0.163 | 0.182 | -0.704 | 0.690 | -1.950 | 1.888 |
| -0.172 | 0.193 | -1.023 | 0.995 | -3.154 | 3.045 |

## PROPIONIC ACID $C_2H_5COOH$.

### Solubility in Water, Determined by the Freezing-point Method.

(Faucon, 1910.)

| t° of Solidif. | Gms. $C_2H_5COOH$ per 100 Gms. Sol. | Solid Phase. | t° of Solidif. | Gms. $C_2H_5COOH$ per 100 Gms. Sol. | Solid Phase. |
|---|---|---|---|---|---|
| — 1.33 | 4.98 | Ice | —17.2 | 73.48 | Ice |
| — 2.60 | 10.11 | " | —21 | 81.75 | " |
| — 3.76 | 15 | " | —29.10 | 86.85 | " |
| — 6.10 | 25 | " | —29.40 | 87.65 | " $+C_2H_5COOH$ |
| — 7.70 | 35.28 | " | —28.30 | 89.12 | $C_2H_5COOH$ |
| — 9.20 | 45.20 | " | —26.90 | 92.40 | " |
| —10.80 | 55 | " | —23.90 | 97.22 | " |
| —14.20 | 65.88 | " | —19.30 | 100 | |

Additional data for this system are given by Tsakalatos (1914), Herz (1917) and Balló (1910). The last-named investigator also determined the composition of the solid phases and explains the abnormal freezing-point lowering on the basis of production of mix-crystals.

The ratio of distribution of propionic acid between water and benzene was found by King and Narracott (1909) to be 1:0.129 at room temperature.

## PROPIONIC ACID $C_2H_5COOH$.

### Distribution of Propionic Acid Between Water and Carbon Tetrachloride at 25°.

(Kolossowski, Bekturof and Kulikow, 1934; Kolossowski, Kulikow and Bekturof, 1935.)

| Gm. Mols. $C_2H_5COOH$ per liter | | $\frac{C_1}{C_2}$ | Gm. Mols. $C_2H_5COOH$ per liter | | $\frac{C_1}{C_2}$ |
|---|---|---|---|---|---|
| $H_2O$ layer($C_1$) | $CCl_4$ layer($C_2$) | | $H_2O$ layer($C_1$) | $CCl_4$ layer($C_2$) | |
| 0.0129 | 0.0004 | 31.5 | 1.529 | 1.033 | 1.48 |
| 0.0368 | 0.00243 | 15.1 | 2.090 | 1.637 | 1.28 |
| 0.0898 | 0.00879 | 10.2 | 2.888 | 2.456 | 1.18 |
| 0.210 | 0.037 | 5.68 | 4.168 | 3.513 | 1.19 |
| 0.445 | 0.128 | 3.48 | 5.183 | 4.172 | 1.24 |
| 0.716 | 0.283 | 2.53 | 7.175 | 5.950 | 1.20 |

### Distribution of Propionic Acid Between Water and Chloroform at 25°

Results of Kolossowsky, Kulikow and Bekturow, 1934, 1936.

| Gm. Mols. $C_2H_5COOH$ per liter | | $\frac{C_1}{C_2}$ | Gm. Mols. $C_2H_5COOH$ per liter | | $\frac{C_1}{C_2}$ |
|---|---|---|---|---|---|
| $H_2O$ layer(1) | $CHCl_3$ layer($C_2$) | | $H_2O$ layer($C_1$) | $CHCl_3$ layer($C_2$) | |
| 0.036 | 0.0075 | 4.80 | 1.004 | 1.500 | 0.666 |
| 0.063 | 0.019 | 4.32 | 1.331 | 2.209 | 0.602 |
| 0.106 | 0.037 | 2.89 | 1.783 | 3.365 | 0.529 |
| 0.160 | 0.081 | 2.09 | 2.285 | 4.243 | 0.539 |
| 0.213 | 0.119 | 1.88 | 2.511 | 4.620 | 0.543 |
| 0.314 | 0.213 | 1.47 | 3.389 | 6.001 | 0.564 |
| 0.389 | 0.326 | 1.19 | 3.854 | 6.302 | 0.612 |
| 0.577 | 0.678 | 0.852 | 4.557 | 6.955 | 0.655 |
| 0.766 | 1.029 | 0.744 | 5.386 | 6.930 | 0.777 |

Results of Smith and White, 1929.

| Gm. Mols. $C_2H_5COOH$ per liter of | |
|---|---|
| $H_2O$ layer | $CHCl_3$ layer |
| 0.03305 | 0.00695 |
| 0.0515 | 0.0127 |
| 0.0643 | 0.0175 |
| 0.0948 | 0.0297 |
| 0.1298 | 0.0491 |
| 0.2005 | 0.1013 |
| 0.2580 | 0.1500 |
| 0.3427 | 0.2458 |
| 0.4150 | 0.3350 |

### Distribution of Propionic Acid at 25° Between : Water and Chloroform.

(Smith, 1921, 1922.)

| Millimols. $C_2H_5COOH$ per liter of | | $\frac{C_2}{C_1}$. |
|---|---|---|
| $H_2O$ layer ($C_1$). | $CHCl_3$ layer ($C_2$). | |
| 2.92 | 0.40 | 0.137 |
| 5.65 | 0.85 | 0.153 |
| 7.12 | 1.175 | 0.165 |
| 10.75 | 1.95 | 0.181 |

### Water and Cotton Seed Oil

(Gordon and Reid, 1922.)

| Gms. $C_2H_5COOH$ per 100 gms. of | | Gms. $C_2H_5COOH$ per 100 gms. of | |
|---|---|---|---|
| $H_2O$ layer. | C. S. oil layer. | $H_2O$ layer. | C. S. oil layer. |
| 3.4 | 0.58 | 36.2 | 9.20 |
| 7.4 | 1.53 | 59.8 | 14.00 |
| 14.3 | 3.48 | 62.5 | 15.00 |
| 23.0 | 6.10 | 67.3 | 17.40 |

## Distribution of Propionic Acid Between Water and Ethyl Bromide at 25°.

(Kolossowski, Becturow and Kulikow, 1934; Kolossowski, Kulikow and Bekturow, 1935.)

| Gm. Mols. $C_2H_5COOH$ per liter | | $\frac{C_1}{C_2}$ | Gm. Mols. $C_2H_5COOH$ per liter | | $\frac{C_1}{C_2}$ |
|---|---|---|---|---|---|
| $H_2O$ layer ($C_1$) | $C_2H_5Br$ layer ($C_2$) | | $H_2O$ layer ($C_1$) | $C_2H_5Br$ layer ($C_2$) | |
| 0.0502 | 0.0113 | 4.14 | 1.1860 | 1.0479 | 1.13 |
| 0.2280 | 0.0729 | 3.16 | 1.4658 | 1.4784 | 0.99 |
| 0.5083 | 0.2510 | 2.02 | 1.6441 | 1.7131 | 0.96 |
| 0.6746 | 0.3891 | 1.73 | 2.3757 | 2.9995 | 0.79 |
| 0.7781 | 0.5083 | 1.53 | 2.7798 | 3.6019 | 0.77 |
| 0.8973 | 0.6401 | 1.40 | 3.4450 | 4.4276 | 0.78 |

## Distribution of Propionic Acid Between Water and Ethyl Ether.

### Results at 18°. (de Kolossowsky, 1925.)

| Gm. mols. $C_2H_5COOH$ per liter of | | Gm. mols. $C_2H_5COOH$ per liter of | | Gm. mols. $C_2H_5COOH$ per liter of | |
|---|---|---|---|---|---|
| $H_2O$ layer. | $(C_2H_5)_2O$ layer. | $H_2O$ layer. | $(C_2H_5)_2O$ layer. | $H_2O$ layer. | $(C_2H_5)_2O$ layer. |
| 0.169 | 0.331 | 0.9427 | 2.4408 | 1.862 | 4.138 |
| 0.324 | 0.676 | 1.143 | 2.857 | 1.9086 | 4.1643 |
| 0.611 | 1.389 | 1.454 | 3.546 | 1.9665 | 4.3089 |
| 0.857 | 2.143 | 1.6022 | 3.8173 | 2.206 | 4.794 |

### Results at 21°-22°

(Behrens, 1926.)

| Concentration. | | | Concentration. | | |
|---|---|---|---|---|---|
| $H_2O$ layer ($b$). | $(C_2H_5)_2O$ layer ($a$). | $\frac{a}{b}$. | $H_2O$ layer ($b$). | $(C_2H_5)_2O$ layer ($a$). | $\frac{a}{b}$. |
| 0.01503 | 0.02560 | 1.703 | 0.03345 | 0.0573 | 1.713 |
| 0.0218 | 0.03715 | 1.704 | 0.0484 | 0.0840 | 1.736 |
| 0.03085 | 0.0529 | 1.715 | 0.06695 | 0.1175 | 1.755 |
| 0.03270 | 0.0559 | 1.710 | | | |

### Results at 25°.

(Smith, 1921, 1922.)

| Millimols. per liter. | | |
|---|---|---|
| $H_2O$ layer ($C_1$). | $(C_2H_5)_2O$ layer ($C_2$). | $\frac{C_2}{C_1}$. |
| 0.675 | 0.8875 | 1.315 |
| 0.925 | 1.225 | 1.325 |
| 2.35 | 3.375 | 1.435 |
| 5.45 | 8.30 | 1.52 |

## Distribution of Propionic Acid between Ether and Aqueous Salt Solutions at 18°. (de Kolossovsky, 1911.)

| Aq. Salt Solution (2 Mols. per Liter). | | $C_2H_5COOH$ per 100 cc. of: | | $\frac{q}{q'}$. |
|---|---|---|---|---|
| Salt. | Gms. Salt per 100 cc. | Aq. Layer ($q$). | Ether Layer ($q'$). | |
| Water alone | | 1.170 | 2.305 | 0.50 |
| NaCl | 11.69 | 0.762 | 2.543 | 0.30 |
| $MgCl_2$ | 19.05 | 0.567 | 3.135 | 0.18 |
| $KNO_3$ | 20.22 | 0.972 | 2.298 | 0.42 |
| $KC_3H_4O_2$ | 22.43 | 1.324 | 2.406 | 0.55 |

## Distribution of Propionic Acid Between Water and Iso Butyl Alcohol at 25°.

(Kolossowski, Bektourov and Kulikow, 1935; Kolossowski, Kulikow and Bektourov, 1936.)

| Gm. Mols. $C_2H_5COOH$ per liter | | $\frac{C_1}{C_2}$ | Gm. Mols. $C_2H_5COOH$ per liter | | $\frac{C_1}{C_2}$ |
|---|---|---|---|---|---|
| $H_2O$ layer ($C_1$) | iso $C_4H_9OH$ layer ($C_2$) | | $H_2O$ layer ($C_1$) | iso $C_4H_9OH$ layer ($C_2$) | |
| 0.0261 | 0.0593 | 0.440 | 0.2253 | 0.6642 | 0.339 |
| 0.0285 | 0.0712 | 0.401 | 0.3321 | 0.9607 | 0.346 |
| 0.0261 | 0.0796 | 0.328 | 0.5811 | 1.5662 | 0.372 |
| 0.0474 | 0.1502 | 0.316 | 0.7828 | 2.0281 | 0.386 |
| 0.0632 | 0.2016 | 0.314 | 0.9607 | 2.4194 | 0.397 |
| 0.0751 | 0.2372 | 0.317 | 1.3165 | 2.9887 | 0.441 |
| 0.1107 | 0.3439 | 0.322 | 1.5774 | 3.3089 | 0.477 |
| 0.1780 | 0.5456 | 0.326 | 1.9687 | 3.5461 | 0.565 |

## PROPIONIC ACID

### Distribution of Propionic Acid Between Water and Each of Several Organic Solvents at 25°.

(Archibald, 1932.)

| Organic Solvent | Formula | Gm. Mols. $C_2H_5COOH$ per liter: $H_2O$ layer ($C_1$) | Gm. Mols. $C_2H_5COOH$ per liter: Organic layer ($C_2$) | $\frac{C_2}{C_1}$ |
|---|---|---|---|---|
| Ethyl Methyl Ketone | $CH_3COC_2H_5$ | 0.07645 | 0.18950 | 2.4787 |
| Tertiary Amyl Alcohol | $CH_3CH_2C(CH_3)OHCH_3$ | 0.05201 | 0.19829 | 3.8125 |
| Secondary Butyl Alcohol | $CH_3CH_2CHOHCH_3$ | 0.07221 | 0.17846 | 2.4714 |
| Normal Butyl Alcohol | $CH_3(CH_2)_2CH_2OH$ | 0.05702 | 0.18620 | 3.2315 |
| Normal Amyl Alcohol | $CH_3(CH_2)_3CH_2OH$ | 0.05334 | 0.18600 | 3.4871 |

### Distribution of Propionic Acid Between Water and Iso Amyl Alcohol at 25°.

(Kolossowski, Bektourow and Kulikow, 1935; Kolossowski, Kulikow and Bektourow, 1935.)

| Gm. Mols. $C_2H_5COOH$ per liter: $H_2O$ layer ($C_1$) | Gm. Mols. $C_2H_5COOH$ per liter: 1 $C_5H_{11}OH$ layer ($C_2$) | $\frac{C_1}{C_2}$ | Gm. Mols. $C_2H_5COOH$ per liter: $H_2O$ layer ($C_1$) | Gm. Mols. $C_2H_5COOH$ per liter: 1 $C_5H_{11}OH$ layer ($C_2$) | $\frac{C_1}{C_2}$ |
|---|---|---|---|---|---|
| 0.003 | 0.006 | 0.50 | 0.251 | 0.711 | 0.35 |
| 0.005 | 0.014 | 0.36 | 0.486 | 1.361 | 0.36 |
| 0.014 | 0.043 | 0.33 | 1.054 | 2.598 | 0.406 |
| 0.023 | 0.071 | 0.32 | 2.089 | 4.292 | 0.487 |
| 0.049 | 0.147 | 0.33 | 2.861 | 4.556 | 0.608 |

### Distribution of Propionic Acid at 25° Between Water and Benzene.

(Brown and Bury, 1923.)

| Normality of $C_2H_5COOH$ in: $H_2O$ layer. | Normality of $C_2H_5COOH$ in: $C_6H_6$ layer. | Normality of $C_2H_5COOH$ in: $H_2O$ layer. | Normality of $C_2H_5COOH$ in: $C_6H_6$ layer. | Normality of $C_2H_5COOH$ in: $H_2O$ layer. | Normality of $C_2H_5COOH$ in: $C_6H_6$ layer. |
|---|---|---|---|---|---|
| 0.154 | 0.0223 | 0.416 | 0.128 | 1.401 | 1.002 |
| 0.191 | 0.0343 | 0.646 | 0.276 | 2.799 | 2.710 |
| 0.340 | 0.0778 | 1.060 | 0.644 | 3.562 | 3.556 |

### Distribution of Propionic Acid Between Water and Benzene.

(Bektourow, 1930a.)

Results at 0°

| Gm. Mols. $C_2H_5COOH$ per liter: $H_2O$ layer ($C_1$) | Gm. Mols. $C_2H_5COOH$ per liter: $C_6H_6$ layer ($C_2$) | $\frac{C_1}{C_2}$ |
|---|---|---|
| 0.1104 | 0.0113 | 9.77 |
| 0.2366 | 0.0378 | 6.26 |
| 0.5394 | 0.1703 | 3.17 |
| 0.9084 | 0.4164 | 2.18 |
| 1.4573 | 0.9274 | 1.57 |
| 2.1292 | 1.8074 | 1.18 |
| 2.9051 | 2.8389 | 1.02 |
| 3.9271 | 4.0218 | 0.98 |
| 5.2046 | 4.9491 | 1.05 |
| 6.3402 | 5.6778 | 1.12 |

Results at 60°

| Gm. Mols. $C_2H_5COOH$ per liter: $H_2O$ layer ($C_1$) | Gm. Mols. $C_2H_5COOH$ per liter: $C_6H_6$ layer ($C_2$) | $\frac{C_1}{C_2}$ |
|---|---|---|
| 0.1419 | 0.0236 | 6.01 |
| 0.3217 | 0.0946 | 3.40 |
| 0.6485 | 0.2839 | 2.27 |
| 0.8463 | 0.5867 | 1.61 |
| 1.2491 | 0.8138 | 1.53 |
| 1.4005 | 1.0031 | 1.40 |
| 1.8737 | 1.5141 | 1.24 |
| 2.9335 | 2.7064 | 1.08 |
| 4.2962 | 4.2205 | 1.02 |
| 5.3939 | 5.1289 | 1.05 |

## Distribution of Propionic Acid at 25° Between:

(Smith and White, 1929.)

### Water and Benzene

### Water and Toluene

| Gm. Mols. $C_2H_5COOH$ per liter | | Gm. Mols. $C_2H_5COOH$ per liter | | Gm. Mols. $C_2H_5COOH$ per liter | | Gm. Mols. $C_2H_5COOH$ per liter | |
|---|---|---|---|---|---|---|---|
| $H_2O$ layer | $C_6H_6$ layer | $H_2O$ layer | $C_6H_6$ layer | $H_2O$ layer | $C_6H_5CH_3$ layer | $H_2O$ layer | $C_6H_5CH_3$ layer |
| 0.0186 | 0.00131 | 0.1241 | 0.0179 | 0.01889 | 0.00102 | 0.1271 | 0.01490 |
| 0.0310 | 0.00245 | 0.2062 | 0.0398 | 0.03146 | 0.00199 | 0.2110 | 0.03500 |
| 0.0503 | 0.00472 | 0.2979 | 0.0792 | 0.05121 | 0.00382 | 0.3110 | 0.06110 |
| 0.0780 | 0.00858 | 0.4540 | 0.1560 | 0.07948 | 0.00705 | 0.4771 | 0.1329 |

## Distribution of Propionic Acid Between Water and Toluene at 25°.

(Kolossowski and Megenine, 1932.)

| Gm. Mols. $C_2H_5COOH$ per liter | | $\frac{C_1}{C_2}$ | Gm. Mols. $C_2H_5COOH$ per liter | | $\frac{C_1}{C_2}$ |
|---|---|---|---|---|---|
| $H_2O$ layer ($C_1$) | $C_6H_5CH_3$ layer ($C_2$) | | $H_2O$ layer ($C_1$) | $C_6H_5CH_3$ layer ($C_2$) | |
| 0.2508 | 0.04918 | 5.10 | 1.6664 | 1.1326 | 1.47 |
| 0.3925 | 0.1075 | 3.65 | 2.238 | 1.762 | 1.27 |
| 0.5280 | 0.1720 | 3.07 | 3.209 | 2.791 | 1.15 |
| 0.6568 | 0.2432 | 2.70 | 4.279 | 3.721 | 1.15 |
| 0.8396 | 0.3604 | 2.33 | 5.434 | 4.566 | 1.19 |
| 1.0613 | 0.5387 | 1.97 | 6.783 | 5.217 | 1.30 |
| 1.2701 | 0.7299 | 1.74 | 7.860 | 6.140 | 1.28 |
| 1.4734 | 0.9266 | 1.59 | 8.000 | 8.000 | 1.00 |

## Distribution of Propionic Acid at 25° Between:

### Water and Nitro Benzene

(Kolossowski, Bektourof and Kulikow, 1934, 1935.)

| Gm. Mols. $C_2H_5COOH$ per liter, | | $\frac{C_1}{C_2}$ |
|---|---|---|
| $H_2O$ layer ($C_1$) | $C_6H_5NO_2$ layer ($C_2$) | |
| 0.0188 | 0.0034 | 5.53 |
| 0.0548 | 0.0117 | 4.68 |
| 0.110 | 0.028 | 3.93 |
| 0.236 | 0.063 | 3.75 |
| 0.502 | 0.131 | 2.77 |
| 0.979 | 0.496 | 1.97 |
| 2.127 | 1.669 | 1.27 |
| 3.232 | 2.830 | 1.14 |
| 4.920 | 4.474 | 1.10 |
| 6.451 | 5.873 | 1.10 |

### Water and o Nitro Toluene

(Kolossowski and Kulikow, 1934; Kolossowski, Kulikow and Bektourov, 1935.)

| Gm. Mols. $C_2H_5COOH$ per liter | | $\frac{C_1}{C_2}$ |
|---|---|---|
| $H_2O$ layer ($C_1$) | o $C_6H_4CH_3NO_2$ layer ($C_2$) | |
| 0.0428 | 0.0059 | 7.25 |
| 0.0898 | 0.0158 | 5.68 |
| 0.1702 | 0.0346 | 4.92 |
| 0.3830 | 0.1040 | 3.68 |
| 0.8924 | 0.3877 | 2.30 |
| 1.619 | 0.931 | 1.74 |
| 3.369 | 2.559 | 1.32 |
| 4.501 | 3.505 | 1.28 |
| 6.714 | 5.177 | 1.30 |
| 8.620 | 7.991 | 1.08 |

### Distribution of Propionic Acid at 25° Between : (Smith, 1921, 1922.)

Water and Xylene.

| Millimols. $C_2H_5COOH$ per liter of $H_2O$ layer ($C_1$). | Millimols. $C_2H_5COOH$ per liter of Xylene layer ($C_2$). | $\frac{C_2}{C_1}$. |
|---|---|---|
| 3.80 | 0.20 | 0.0528 |
| 9.20 | 0.60 | 0.065 |
| 19.30 | 1.30 | 0.067 |

Acetone and Glycerol.

| Millimols. $C_2H_5COOH$ per liter of Acetone layer (A) | Millimols. $C_2H_5COOH$ per liter of Glycerol layer (G). | $\frac{A}{G}$ |
|---|---|---|
| 1.73 | 0.43 | 4.05 |
| 3.06 | 0.78 | 3.93 |
| 5.76 | 1.48 | 3.80 |

| Millimols. $C_2H_5COOH$ per liter Acetone layer (A). | Glycerol layer (G). | $\frac{A}{G}$. |
|---|---|---|
| 7.45 | 2.15 | 3.46 |
| 10.85 | 3.50 | 3.10 |
| 19.40 | 5.80 | 3.34 |
| 31.00 | 9.60 | 3.23 |

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### Distribution of Propionic Acid at 25° Between:

(Kolossowski, Bektourow and Kulikow, 1934; Kolossowski, Kulikow and Bektourow, 1935.)

Water and Xylene

| Gm. Mols. $C_2H_5COOH$ per liter $H_2O$ layer($C_1$) | $C_6H_4(CH_3)_2$ layer($C_2$) | $\frac{C_1}{C_2}$ |
|---|---|---|
| 0.108 | 0.008 | 13.5 |
| 0.119 | 0.012 | 9.92 |
| 0.301 | 0.046 | 6.51 |
| 0.552 | 0.129 | 4.28 |
| 1.060 | 0.410 | 2.59 |
| 1.544 | 0.816 | 1.89 |
| 2.423 | 1.443 | 1.68 |
| 4.394 | 2.862 | 1.53 |
| 5.310 | 3.364 | 1.58 |
| 6.566 | 4.092 | 1.60 |
| 7.683 | 5.000 | 1.53 |
| 8.374 | 6.732 | 1.245 |

Water and Decaline

| Gm. Mols. $C_2H_5COOH$ per liter $H_2O$ layer($C_1$) | $C_{10}H_{18}$ layer($C_2$) | $\frac{C_1}{C_2}$ |
|---|---|---|
| 0.0337 | 0.00131 | 25.7 |
| 0.0642 | 0.00262 | 24.5 |
| 0.1642 | 0.0089 | 18.3 |
| 0.332 | 0.0215 | 15.4 |
| 0.676 | 0.0658 | 10.9 |
| 0.947 | 0.114 | 8.31 |
| 2.007 | 0.358 | 5.61 |
| 3.719 | 0.730 | 5.09 |
| 5.098 | 0.964 | 5.29 |
| 8.850 | 2.198 | 4.03 |
| 9.056 | 4.649 | 1.95 |
| 8.583 | 5.426 | 1.58 |

### Equilibrium in the System Propionic Acid, Aniline and Water.

(Angelescu, 1928.)

Results at 0°

| Gms. per 100 gms. homogeneous mixture $C_2H_5COOH$ | $C_6H_5NH_2$ | Gms. per 100 gms. homogeneous mixture $C_2H_5COOH$ | $C_6H_5NH_2$ |
|---|---|---|---|
| 0.0 | 3.68 | 28.68 | 36.84 |
| 0.98 | 4.63 | 28.99 | 41.06 |
| 2.56 | 6.03 | 27.92 | 48.13 |
| 4.59 | 7.52 | 25.30 | 55.0 |
| 10.03 | 10.46 | 23.32 | 60.25 |
| 15.55 | 14.19 | 20.93 | 64.88 |
| 20.25 | 19.39 | 14.75 | 75.51 |
| 23.36 | 24.35 | 7.86 | 85.74 |
| 25.63 | 28.57 | 1.26 | 94.21 |
| 27.61 | 33.12 | 0.0 | 95.71 |

Results at 20°

| Gms. per 100 gms. homogeneous mixture $C_2H_5COOH$ | $C_6H_5NH_2$ | Gms. per 100 gms. homogeneous mixture $C_2H_5COOH$ | $C_6H_5NH_2$ |
|---|---|---|---|
| 0.0 | 3.59 | 26.77 | 37.99 |
| 1.51 | 5.06 | 27.11 | 40.61 |
| 3.75 | 6.43 | 26.37 | 48.87 |
| 9.89 | 9.72 | 24.29 | 55.77 |
| 15.13 | 13.73 | 20.79 | 63.71 |
| 19.68 | 19.90 | 17.97 | 69.10 |
| 22.40 | 25.36 | 11.05 | 80.33 |
| 24.34 | 29.87 | 6.44 | 86.93 |
| 25.81 | 33.78 | 1.93 | 92.76 |
| 26.33 | 35.63 | 0.0 | 94.84 |

The author also determined the distribution of Propionic acid between water and aniline at 20°.

| Gms. $C_2H_5COOH$ per 100 gms. $H_2O$ layer($C_1$) | Gms. $C_2H_5COOH$ per 100 gms. $C_6H_5NH_2$ layer($C_2$) | $\frac{C_1}{C_2}$ | Gms. $C_2H_5COOH$ per 100 gms. $H_2O$ layer($C_1$) | Gms. $C_2H_5COOH$ per 100 gms. $C_6H_5NH_2$ layer($C_2$) | $\frac{C_1}{C_2}$ |
|---|---|---|---|---|---|
| 0.51 | 0.34 | 1.50 | 8.86 | 18.00 | 0.49 |
| 1.00 | 0.99 | 1.01 | 10.76 | 22.07 | 0.49 |
| 1.73 | 2.04 | 0.85 | 11.54 | 23.81 | 0.48 |
| 2.58 | 3.56 | 0.72 | 12.46 | 24.93 | 0.50 |
| 4.18 | 6.77 | 0.62 | 12.98 | 25.30 | 0.51 |
| 4.50 | 7.54 | 0.60 | 15.06 | 27.36 | 0.55 |
| 6.10 | 11.64 | 0.55 | 17.35 | 27.44 | 0.63 |
| 6.74 | 12.57 | 0.55 | | | |

It was also found that at concentrations of propionic acid between 24.56 and 30.16 percent, closed curves corresponding to the solubility of aniline at varying temperatures were obtained.

## Equilibrium in the System Propionic Acid Ortho Toluidine and Water.

(Angelescu, 1928.)

| Results at 0° | | | | Results at 20° | | | |
|---|---|---|---|---|---|---|---|
| Gms. per 100 gms. homogeneous mixture | | Gms. per 100 gms. homogeneous mixture | | Gms. per 100 gms. homogeneous mixture | | Gms. per 100 gms. homogeneous mixture | |
| $C_2H_5COOH$ | o $CH_3C_6H_4NH_2$ | $C_2H_5COOH$ | o $CH_3C_6H_4NH_2$ | $C_2H_5COOH$ | o $CH_3C_6H_4NH_2$ | $C_2H_5COOH$ | o $CH_3C_6H_4NH_2$ |
| 0.0 | 1.68 | 34.22 | 33.70 | 0.0 | 1.69 | 33.81 | 38.59 |
| 1.71 | 3.26 | 34.42 | 41.01 | 5.80 | 4.28 | 32.74 | 45.59 |
| 4.01 | 4.48 | 32.37 | 48.56 | 10.16 | 5.66 | 29.51 | 54.38 |
| 9.68 | 6.63 | 28.38 | 57.30 | 14.26 | 7.33 | 24.87 | 63.25 |
| 16.49 | 9.87 | 23.23 | 66.22 | 19.36 | 10.52 | 19.17 | 72.52 |
| 20.88 | 12.90 | 16.87 | 75.93 | 24.09 | 15.54 | 12.34 | 81.92 |
| 24.92 | 17.16 | 6.45 | 89.64 | 28.54 | 22.57 | 8.54 | 86.91 |
| 29.85 | 24.30 | 2.23 | 94.75 | 31.72 | 28.74 | 3.39 | 93.34 |
| 33.26 | 30.94 | 0.0 | 97.65 | 33.31 | 33.45 | 0.0 | 97.50 |

The author also determined the distribution of Propionic Acid between Water and o Toluidine at 20°.

| Gms. $C_2H_5COOH$ per 100 gms. $H_2O$ layer($C_1$) | Gms. $C_2H_5COOH$ per 100 gms. o $CH_3C_6H_4NH_2$ layer($C_2$) | $\frac{C_1}{C_2}$ | Gms. $C_2H_5COOH$ per 100 gms. $H_2O$ layer($C_1$) | Gms. $C_2H_5COOH$ per 100 gms. o $CH_3C_6H_4NH_2$ layer($C_2$) | $\frac{C_1}{C_2}$ |
|---|---|---|---|---|---|
| 0.25 | 0.26 | 0.962 | 9.09 | 19.27 | 0.472 |
| 0.92 | 1.22 | 0.754 | 11.36 | 24.84 | 0.457 |
| 2.15 | 3.49 | 0.616 | 12.71 | 27.84 | 0.457 |
| 4.00 | 7.12 | 0.562 | 13.58 | 29.28 | 0.462 |
| 6.03 | 11.40 | 0.525 | 14.45 | 30.52 | 0.473 |
| 8.11 | 16.74 | 0.484 | 17.42 | 33.73 | 0.516 |

Results are also given for the upper temperatures of solution of mixtures containing from 30.61 to 34.10 percent Propionic acid and varying percentages of o toluidine.

### Distribution of Propionic Acid Between Water and Petroleum Ether at Room Temperature.

(Grossfield and Miermeister, 1932.)

| cc 0.1n NaOH required per 25 cc of: $H_2O$ layer(1) | Pet. Ether layer(2) | $\frac{1}{2}$ | cc 0.1n NaOH required per 25 cc of: $H_2O$ layer(1) | Pet. Ether layer(2) | $\frac{1}{2}$. |
|---|---|---|---|---|---|
| 1.0 | 0.046 | 21.7 | 62.9 | 2.85 | 22.1 |
| 3.47 | 0.078 | 44.5 | 100.4 | 7.63 | 13.2 |
| 11.1 | 0.168 | 65.9 | 183.5 | 20.7 | 8.87 |
| 25.9 | 0.595 | 43.5 | 293.5 | 48.5 | 6.05 |

### Distribution of Propionic Acid Between Water and Olive Oil.

(Bodansky, 1928; Bodansky and Meigs, 1932.)

Results at 25°

| Gm. Mols. $C_2H_5COOH$ per liter $H_2O$ layer(1) | Oil layer(2) | $\frac{1}{2}$ |
|---|---|---|
| 0.0176 | 0.0028 | 6.28 |
| 0.043 | 0.0072 | 5.96 |
| 0.087 | 0.0144 | 6.04 |
| 0.173 | 0.0290 | 5.97 |
| 0.218 | 0.0360 | 6.25 |

Results at 37.5°

| Gm. Mols. $C_2H_5COOH$ per liter $H_2O$ layer(1) | Oil layer(2) | $\frac{1}{2}$ |
|---|---|---|
| 0.0406 | 0.0096 | 4.23 |
| 0.0830 | 0.0185 | 4.49 |
| 0.1680 | 0.0316 | 5.32 |
| 0.2090 | 0.0430 | 5.19 |

### Distribution of Propionic Acid Between Glycerol and Chloroform at 25°.

(Kolossowsky and Kulikow, 1935a.)

| Gm. Mols. $C_2H_5COOH$ per liter Glycerol layer(1) | $CHCl_3$ layer(2) | $\frac{1}{2}$ | Gm. Mols. $C_2H_5COOH$ per liter Glycerol layer(1) | $CHCl_3$ layer(2) | $\frac{1}{2}$ |
|---|---|---|---|---|---|
| 0.348 | 0.405 | 0.859 | 2.328 | 4.022 | 0.579 |
| 0.543 | 0.817 | 0.665 | 2.981 | 4.468 | 0.667 |
| 0.793 | 1.538 | 0.516 | 3.489 | 4.455 | 0.783 |
| 1.299 | 2.598 | 0.500 | 3.545 | 4.462 | 0.794 |
| 1.801 | 3.489 | 0.516 | | | |

Freezing-point data are given for:

| | |
|---|---|
| Propionic Acid + Methyl Alcohol | (Baume and Pamfil, 1914.) |
| " " + " " HCl | " " " |
| " " + iso Butyric Acid | (Timmermans, 1934.) |
| " " + n Valeric Acid | " " |
| " " + iso " " | " " |
| " " + 2- Naphthylamine | {Brady and Truszkowski, 1924. Kremann, Weber and Zechner, 1925.} |

**TRI METHYLENE TRISULFIDE DIOXIDE** α and β $C_3H_6O_2S$.

**TRI METHYLENE TRISULFOXIDE** α and β $C_3H_6O_3S$.

### Solubility of Each Separately in Water at 25°.

(Bell and Bennett, 1929.)

| Compound | Formula | Gms. Compound per 100 gms. $H_2O$ |
|---|---|---|
| α Tri methylene Trisulfide Dioxide | $C_3H_6O_2S_3$ | 1.70 |
| β " " " " | " | 4.53 |
| α Tri methylene Trisulfoxide | $C_3H_6O_3S_3$ | 0.134 |
| β " " " | " | 1.437 |

**LACTIC ACID** (*i*) $CH_3CHOHCOOH$.

### Distribution Between Water and Ether.

(Pinnow, 1915.)

| Results at 15°. Gm. Mols. Acid per Liter: $H_2O$ Layer ($w$). | Ether Layer ($e$). | $\frac{w}{e}$. | Results at 27.5°. Gm. Mols. Acid per Liter: $H_2O$ Layer ($w$). | Ether Layer ($e$). | $\frac{(w)}{(e)}$. |
|---|---|---|---|---|---|
| 1.98 | 0.215 | 9.19 | 1.354 | 0.130 | 10.42 |
| 1.351 | 0.133 | 10.15 | 0.3203 | 0.0278 | 11.52 |
| 0.297 | 0.0246 | 12.08 | 0.1855 | 0.0156 | 11.89 |
| 0.1448 | 0.0118 | 12.27 | | | |
| 0.0548 | 0.0046 | 11.88 | | | |

F.-pt. data for mixtures of trichlorolactic acid and dimethylpyrone are given by Kendall, 1914.

### Distribution of Lactic Acid Between :

Water and Chloroform at 25°. (Smith, 1922, 1921.)

| Millimols. per liter. $H_2O$ layer ($C_1$). | $CHCl_3$ layer ($C_2$). | $\frac{C_2}{C_1}$ |
|---|---|---|
| 26.9 | 0.43 | 0.0160 |
| 32.8 | 0.60 | 0.0183 |
| 50.4 | 1.00 | 0.0198 |
| 79.8 | 1.80 | 0.0226 |

Water and Ether at 25°. (Smith, 1921, 1922.)

| Millimols. per liter. $H_2O$ layer $C_1$). | $(C_2H_5)_2O$ layer ($C_2$). | $\frac{C_2}{C_1}$. |
|---|---|---|
| 3.95 | 0.550 | 0.139 |
| 5.95 | 1.000 | 0.155 |
| 9.35 | 1.525 | 0.163 |
| 15.7 | 2.7 | 0.172 |
| 28 3 | 5.1 | 0.180 |

Water and Ether at 20°. (Behrens, 1926.)

| Concentration in $H_2O$ layer $C_1$). | $(C_2H_5)_2O$ layer ($C_2$). | $\frac{C_2}{C_1}$. |
|---|---|---|
| 0.0692 | 0.0056 | 0.0809 |
| 0.1485 | 0.01205 | 0.0811 |
| 0.298 | 0.02445 | 0.0820 |

### Distribution of Anhydride Free Lactic Acid Between Water and Ethyl Ether at 20°.

(Dietzel and Rosenbaum, 1927; Dietzel and Schmitt, 1932.)

| Gm. Mol. $CH_3CHOHCOOH$ per liter $H_2O$ layer | $(C_2H_5)_2O$ layer | Gm. Mol. $CH_3CHOHCOOH$ per liter $H_2O$ layer | $(C_2H_5)_2O$ layer | Gm. Mol. $CH_3CHOHCOOH$ per liter $H_2O$ layer | $(C_2H_5)_2O$ layer |
|---|---|---|---|---|---|
| 0.1270 | 0.0144 | 0.3440 | 0.0321 (10°) | 0.8020 | 0.0707 |
| 0.1470 | 0.0158 | 0.3350 | 0.0322 ( 0°) | 0.8600 | 0.0752 |
| 0.1630 | 0.0173 | 0.3850 | 0.0354 | 0.9310 | 0.0814 |
| 0.2010 | 0.0201 | 0.4910 | 0.0446 | 0.985 | 0.0883 |
| 0.2550 | 0.0249 | 0.5660 | 0.0504 | 1.040 | 0.0934 |
| 0.3110 | 0.0295 | 0.6220 | 0.0553 | 1.095 | 0.0985 |
| 0.3522 | 0.0320 | 0.6770 | 0.0597 | 1.150 | 0.1036 |
| 0.3575 | 0.0320 (25°) | 0.7500 | 0.0659 | 1.205 | 0.1087 |

### Distribution of Anhydride Free Lactic Acid Between 0.5n Aq. Sulfuric Acid and Ethyl Ether at 20°.

(Dietzel and Rosenbaum, 1927.)

| Gm. Mol. $CH_3CHOHCOOH$ per liter 0.5n $H_2SO_4$ layer | $(C_2H_5)_2O$ layer | Gm. Mol. $CH_3CHOHCOOH$ per liter 0.5n $H_2SO_4$ layer | $(C_2H_5)_2O$ layer | Gm. Mol. $CH_3CHOHCOOH$ per liter 0.5n $H_2SO_4$ layer | $(C_2H_5)_2O$ layer |
|---|---|---|---|---|---|
| 0.0684 | 0.0058 | 0.2300 | 0.0199 | 0.6680 | 0.0600 |
| 0.0881 | 0.0075 | 0.3170 | 0.0278 | 0.7550 | 0.0680 |
| 0.1029 | 0.0088 | 0.4040 | 0.0360 | 0.8380 | 0.0758 |
| 0.1260 | 0.0108 | 0.4900 | 0.0440 | 0.9250 | 0.0835 |
| 0.1580 | 0.0137 | | | | |

## Distribution of Anhydride Free Lactic Acid Between Water and Amyl Alcohol at 20°.

(Dietzel and Rosenbaum, 1927; Dietzel and Schmitt, 1932.)

| Gm. Mol. $CH_3CHOHCOOH$ per liter | | Gm. Mol. $CH_3CHOHCOOH$ per liter | | Gm. Mol. $CH_3CHOHCOOH$ per liter | |
|---|---|---|---|---|---|
| $H_2O$ layer | $C_5H_{11}OH$ layer | $H_2O$ layer | $C_5H_{11}OH$ layer | $H_2O$ layer | $C_5H_{11}OH$ layer |
| 0.1040 | 0.0490 | 0.3880 | 0.1610 | 0.6800 | 0.2775 |
| 0.1330 | 0.0605 | 0.4250 | 0.1760 | 0.714 | 0.3170 |
| 0.1650 | 0.0725 | 0.4630 | 0.1910 | 0.918 | 0.4110 |
| 0.2030 | 0.0875 | 0.5000 | 0.2060 | 0.969 | 0.4345 |
| 0.2060 | 0.0825 | 0.5100 | 0.2230 | 1.020 | 0.4580 |
| 0.2420 | 0.1025 | 0.5370 | 0.2210 | 1.071 | 0.4815 |
| 0.2790 | 0.1170 | 0.5700 | 0.2320 | 1.122 | 0.5050 |
| 0.3190 | 0.1330 | 0.6070 | 0.2480 | 1.173 | 0.5285 |
| 0.3530 | 0.1470 | 0.6430 | 0.2625 | | |

## Distribution of Anhydride Free Lactic Acid Between 0.5n Aq. Sulfuric Acid and Amyl Alcohol at 20°.

(Dietzel and Rosenbaum, 1927.)

| Gm. Mol. $CH_3CHOHCOOH$ per liter | | Gm. Mol. $CH_3CHOHCOOH$ per liter | | Gm. Mol. $CH_3CHOHCOOH$ per liter | |
|---|---|---|---|---|---|
| 0.5n $H_2SO_4$ layer | $C_5H_{11}OH$ layer | 0.5n $H_2SO_4$ layer | $C_5H_{11}OH$ layer | 0.5n $H_2SO_4$ layer | $C_5H_{11}OH$ layer |
| 0.0410 | 0.0190 | 0.2530 | 0.1100 | 0.4940 | 0.2100 |
| 0.0705 | 0.0320 | 0.2890 | 0.1250 | 0.5260 | 0.2235 |
| 0.1000 | 0.0455 | 0.3230 | 0.1390 | 0.5640 | 0.2450 |
| 0.1240 | 0.0560 | 0.3560 | 0.1525 | 0.5950 | 0.2520 |
| 0.1490 | 0.0680 | 0.3905 | 0.1675 | 0.6310 | 0.2660 |
| 0.1830 | 0.0825 | 0.4260 | 0.1825 | 0.6640 | 0.2800 |
| 0.2170 | 0.0950 | 0.4580 | 0.1950 | 0.6980 | 0.2940 |

The authors also give similar results for the distribution of commercial Lactic Acid containing 30% Lactyl Lactic Acid, $[CH_3.CH(OH).COOCH(CH_3).COOH]$, between Water and Amyl Alcohol at 20°.

## Distribution of Lactic Acid Between Water and Iso Amyl Alcohol at 25°.

(Kolossowsky and Bekturow, 1935; Kolossowsky, Kulikow and Bekturow, 1936.)

| Gm. Mols. $CH_3CHOHCOOH$ per liter | | $\frac{1}{2}$ | Gm. Mols. $CH_3CHOHCOOH$ per liter | | $\frac{1}{2}$ |
|---|---|---|---|---|---|
| $H_2O$ layer(1) | iso $C_5H_{11}OH$ layer(2) | | $H_2O$ layer(1) | iso $C_5H_{11}OH$ layer(2) | |
| 0.152 | 0.058 | 2.62 | 1.750 | 0.884 | 1.98 |
| 0.358 | 0.145 | 2.47 | 2.760 | 1.616 | 1.71 |
| 0.526 | 0.221 | 2.38 | 3.218 | 2.051 | 1.57 |
| 0.8006 | 0.358 | 2.24 | 3.919 | 2.974 | 1.32 |
| 1.350 | 0.656 | 2.06 | 4.178 | 3.477 | 1.20 |

## Distribution of Lactic Acid Between Water and Ortho Toluidine at 30°.

(Angelescu, 1927.)

| Gms. $CH_3CHOHCOOH$ per 100 gms. | | $\frac{1}{2}$ | Gms. $CH_3CHOHCOOH$ per 100 gms. | | $\frac{1}{2}$ |
|---|---|---|---|---|---|
| $H_2O$ layer(1) | o $CH_3C_6H_4NH_2$ layer(2) | | $H_2O$ layer(1) | o $CH_3C_6H_4NH_2$ layer(2) | |
| 3.86 | 0.65 | 5.94 | 15.61 | 6.41 | 2.43 |
| 6.95 | 1.31 | 5.30 | 16.65 | 9.14 | 1.82 |
| 9.78 | 2.27 | 4.31 | 16.78 | 10.68 | 1.57 |
| 12.17 | 3.47 | 3.51 | 16.83 | 11.23 | 1.50 |

Magnesium **LACTATE** $Mg(CH_3CHOHCOO)_2.2\frac{1}{2}H_2O$.

100 cc 95% Ethyl Alcohol dissolve 0.0204 gm. $Mg(CH_3CHOHCOO)$ at 23.25°.
(McDermott, 1940.)

## HYDANTOIC ACID $NH_2CONHCH_2COOH$.

### Solubility of Hydantoic Acid in Several Solvents at 25°.

(McMeekin, Cohn and Weare, 1936.)

| Solvent | d. of sat. sol. | Gm. Mol. $C_3H_6O_3N_2$ per liter sat. sol. | Solvent | d. of sat. sol. | Gm. Mol. $C_3H_6O_3N_2$ per liter sat. sol. |
|---|---|---|---|---|---|
| Water | 1.0112 | 0.329 | 90 Wt. % Ethanol | 0.82887 | 0.710 |
| Formamide | 1.15405 | 0.837 | 100 " " | 0.7865 | 0.0242 |
| Methanol | 0.79178 | 0.0797 | Butanol | 0.80674 | 0.00643 |
| Acetone | 0.78566 | 0.00248 | | | |

### Solubility of Hydantoic Acid in Aqueous Ethyl Alcohol at 25°.

(McMeekin, Cohn and Weare, 1936.)

| Vol. Percent $C_2H_5OH$ in Aq. Solvent | d. of sat. sol. | Gm. Mols. $C_3H_6O_3N_2$ per liter | Vol. Percent $C_2H_5OH$ in Aq. Solvent | d. of sat. sol. | Gm. Mols. $C_3H_6O_3N_2$ per liter |
|---|---|---|---|---|---|
| 0.0 | 1.0112 | 0.329 | 60.0 | 0.9166 | 0.211 |
| 20.0 | 0.9835 | 0.272 | 80.0 | 0.8619 | 0.124 |
| 40.0 | 0.9575 | 0.246 | 100.0 | 0.7865 | 0.0242 |

## TRI METHYLENE TRI NITRAMINE $(CH_2N)_3(NO_2)_3$.

### Solubility of Tri Methylene Tri Nitramine in Several Solvents, Each Separately.

(Urbanski and Kwiatkowski, 1933.)

| t° | Gms. $(CH_2N)_3(NO_2)_3$ per 100 gms. sat. sol. in: $CH_3OH$ | $C_2H_5OH$ | iso $C_5H_{11}OH$ | $(CH_3)_2CO$ | $CH_3COOC_2H_5$ | $CCl_4$ | $C_6H_6$ | $C_6H_5CH_3$ |
|---|---|---|---|---|---|---|---|---|
| 0 | 0.140 | 0.040 | 0.020 | 4.18 | — | — | — | 0.016 |
| 10 | 0.180 | 0.070 | 0.023 | 5.38 | 0.050 | — | 0.020 | 0.018 |
| 20 | 0.235 | 0.105 | 0.026 | 6.81 | 0.055 | — | 0.045 | 0.020 |
| 30 | 0.325 | 0.155 | 0.040 | 8.38 | 0.075 | — | 0.055 | 0.025 |
| 40 | 0.480 | 0.235 | 0.060 | 10.34 | 0.090(a) | — | 0.085 | 0.050 |
| 50 | 0.735 | 0.370 | 0.110 | 12.80 | — | 0.005 | 0.115 | 0.085 |
| 60 | 1.060 | 0.575 | 0.210 | 15.27(b) | — | 0.007 | 0.195 | 0.125 |
| 70 | 1.250(c) | 0.880 | 0.320 | ← | — | 0.015 | 0.300 | 0.210 |
| 80 | — | 1.180(d) | 0.500 | — | — | — | 0.400(e) | 0.295 |
| 90 | — | — | 0.850 | — | — | — | — | 0.465 |
| 100 | — | — | 1.325 | — | — | — | — | 0.640 |
| 110 | — | — | 1.900 | — | — | — | — | 0.980 |
| 120 | — | — | 2.990 | — | — | — | — | — |
| | — | — | 3.870(f) | — | — | — | — | — |

(a) 34°; (b) 58°; (c) 64.5°; (d) 78.1°; (e) 79.5°; (f) 131.6°.

Freezing-point data are given by Urbanski and Rabek-Gawronska, 1934, for mixtures of Tri methylene Tri nitramine and each of the following compounds: Dimethyl diphenyl urea, 1.2.3 Trinitro benzene, 2.4.6 Tri nitro phenol, 2.4.6 Tri nitro toluene, Tri nitro phenyl methyl nitramine (Tetryl), m Dinitrobenzene, Diphenyl amine, p Nitro anisole, Nitro naphthalene and p Nitro toluene.

## PROPYL CHLORIDE, Bromide, etc.

### Solubility in Water.

(Rex, 1906.)

| Propyl Compound. | Grams P. Compound per 100 Gms $H_2O$ at: 0°. | 10°. | 20°. | 30°. |
|---|---|---|---|---|
| $CH_3CH_2CH_2Cl$ (normal) | 0.376 | 0.323 | 0.272 | .0.277 |
| $CH_3CH_2CH_2Br$ " | 0.298 | 0.263 | 0.245 | 0.247 |
| $CH_3CH_2CH_2I$ " | 0.114 | 0.103 | 0.107 | 0.103 |
| $(CH_3)_2CHCl$ (iso) | 0.440 | 0.363 | 0.305 | 0.304 |
| $(CH_3)_2CHBr$ " | 0.418 | 0.365 | 0.318 | 0.318 |
| $(CH_3)_2CHI$ " | 0.167 | 0.143 | 0.140 | 0.134 |

## PROPYL ACETATE, BROMIDE, CHLORIDE, etc.

### Solubility of Each Separately in Water. (Führer, 1924.)

The determinations were made simply by measuring from a buret the quantity of each compound just sufficient to saturated a given amount of water after thorough shaking. High accuracy is not claimed for the results.

| Compound. | Formula. | t°. | Gms. cmpd. per 100 gms. sat. sol. |
|---|---|---|---|
| *n* Propyl Acetate..... | $CH_3COO.CH_2CH_2CH_3$ | 20 | 1.89 |
| Iso » » ..... | $CH_3COO(CH_3)_2CH$ | 20 | 3.09 |
| » Butyrate..... | $C_3H_7COO.C_3H_7$ | 17 | 0.162 |
| » Benzene..... | $CH_3(CH_2)_2.C_6H_5$ | 15 | 0.006 |
| » Bromide..... | $CH_3CH_2CH_2Br$ | 19.5 | 0.226 |
| Iso » » ..... | $(CH_3)_2CHBr$ | 18. | 0.286 |
| » Chloride..... | $CH_3CH_2CH_2Cl$ | 12.5 | 0.232 |
| Iso » » ..... | $(CH_3)_2CHCl$ | 12.5 | 0.342 |
| » Iodide..... | $CH_3CH_2CH_2I$ | 20 | 0.087 |

## PROPYL BROMIDE

100 gms. $H_2O$ dissolve 0.231 gms. n Propyl Bromide at 30°.
100 gms. $H_2O$ dissolve 0.104 gm. n Propyl Iodide at 30°. (Gross and Saylor, 1931.)

Freezing-Point data are given for:

n Propyl Bromide + Ethyl Bromide (Sapgir, 1929.)
" " + iso Butyl Bromide (Timmermans, 1934.)

## PROPYL AMINES

Freezing-point data for mixtures of propylamine and water, isopropylamine and water and for dipropylamine and water are given by Pickering (1893).

### Distribution of Propylamines between Water and Toluene.

(Moore and Winmill, 1912.)

| Amine. | Results at 18°. Gm. Equiv. Amine per Liter of Aq. Layer. | Partition Coef. | Results at 25°. Gm. Equiv. Amine per Liter of Aq. Layer. | Partition Coef. | Results at 32.35°. Gm. Equiv. Amine per Liter of Aq. Layer. | Partition Coef. |
|---|---|---|---|---|---|---|
| Propylamine | 0.0973 | 5.434 | 0.03837 | 4.470 | 0.0602 | 3.311 |
| " | 0.0928 | 5.439 | 0.04300 | 4.470 | 0.0578 | 3.317 |
| Dipropylamine | 0.0764 | 0.1185 | 0.0722 | 0.0769 | 0.01168 | 0.05802 |
| " | 0.0794 | 0.1188 | 0.0681 | 0.0771 | 0.01199 | 0.05795 |
| Tripropylamine | 0.0003 | 0.003' | ... | ... | ... | ... |

**PROPYLAMINE HYDROCHLORIDE** $\alpha$ $NH_2(C_3H_7).HCl$.

100 gms. $H_2O$ dissolve 278.2 gms. $NH_2(C_3H_7).HCl$ at 25°. (Peddle and Turner, 1913.)
100 gms. $CHCl_3$ dissolve 5.26 gms. $NH_2(C_3H_7).HCl$ at 25°. (Peddle and Turner, 1913.)

Di**PROPYL AMINE HYDROCHLORIDE** $NH(C_3H_7)_2.HCl$.

100 gms. $H_2O$ dissolve 165.3 gms. $NH(C_3H_7)_2.HCl$ at 25°. (Peddle and Turner, 1913.)
100 gms. $CHCl_3$ dissolve 47.24 gms. $NH(C_3H_7)_2.HCl$ at 25°. (Peddle and Turner, 1913.)

**PROPIONAMIDE** $CH_3CH_2CONH_2$.

CRITICAL SOLUTION TEMPERATURES OF PROPIONAMIDE AND OTHER COMPOUNDS.

| Mixture of Propionamide and: | Formula | Critical solution Temperature | Authority |
|---|---|---|---|
| p Chloro nitro benzene | $C_6H_4ClO_2N$ | 66.5 | (Lecat, 1929.) |
| Methyl benzene | $C_6H_5CH_3$ | about 57 | ( " 1927a) |
| p Methyl acetophenone | $C_9H_{10}O$ | 50(?) | ( " " ) |
| Benzyl acetate | $C_9H_{10}O_2$ | about 50 | ( " 1928.) |
| Ethyl benzoate | $C_6H_5COOC_2H_5$ | about 65 | ( " " |
| Geraniol | $C_{10}H_{18}O$ | about 55 | ( " 1929.) |
| i Amyl valerianate | $C_{10}H_{20}O$ | 70 | ( " 1927a) |
| Eugenol methyl ether | $C_{11}H_{14}O$ | about 55 | ( " 1928.) |

**ALLYLAMINE** $CH_2 : CH.CH_2.NH_2$.

DISTRIBUTION BETWEEN WATER AND XYLENE AT 25°. (Smith, 1921-1922.)

| Gm. mols. Allylamine per liter | | | | |
|---|---|---|---|---|
| $H_2O$ layer..... | 1.85 | 3.30 | 6.50 |
| Xylene layer..... | 0.35 | 0,55 | 1.30 |

**ALANINE** ($\alpha$ Aminopropionic Acid) $CH_3CH(NH_2)COOH$.

SOLUBILITY OF *d* ALANINE AND OF *dl* ALANINE IN WATER AT DIFFERENT TEMPERATURES.

(Pellini and Coppola, 1913.)

| Results for: | *d* Alanine. | *d* − *l* Alanine. | Mixtures *d* + *l* Alanine. Gms. per 100 Gms. $H_2O$. | |
|---|---|---|---|---|
| t°. | Gms. *d* Alanine per 100 Gms. $H_2O$. | Gms. *d* − *l* Alanine per 100 Gms. $H_2O$. | *d* Alanine. | *l* Alanine. |
| 0 | 12.99 | 12.89 | 13.27 | 4.01 |
| 17 | 15.17 | 14.95 | 14.5 | 4.1 |
| 30 | 17.39 | 17.72 | 17.05 | 4.99 |
| 45 | 20.55 | 21.58 | ... | ... |

### Solubility of d Alanine and of dl Alanine, Each Separately, in Water at Different Temperatures.

(Dalton and Schmidt, 1933.)

The following results were derived from equations based in each case upon 18 very careful solubility determinations at 9 different temperatures between 0 and 65°.

Results are also given for the densities at 25° of solutions of d Alanine varying from 0.89 to 14.38 percent and for dl Alanine varying from 1.1 to 15.0 percent. The following results in parentheses are those of Dunn, Ross and Read, 1933.

| t° | Gms. per 100 gms. $H_2O$ | | t° | Gms. per 100 gms. $H_2O$ | |
|---|---|---|---|---|---|
| | d Alanine | dl Alanine | | d Alanine | dl Alanine |
| 0 | 12.73 | 12.11(12.11) | 40 | 19.57 | 20.29 |
| 5 | 13.43 | 12.91 | 45 | 20.65 | 21.64 |
| 10 | 14.17 | 13.78 | 50 | 21.79 | 23.09(23.48) |
| 15 | 14.96 | 14.69 | 55 | 22.99 | 24.63 |
| 20 | 15.78 | 15.67 | 60 | 24.26 | 26.27 |
| 25 | 16.65 | 16.72(16.58) | 65 | 25.60 | 28.02 |
| 30 | 17.57 | 17.88 | 70 | 27.02 | 29.90 |
| 35 | 18.54 | 19.02 | 75 | 28.51 | 31.89(32.18) |
| | | | 100 | 37.30 | 44.04(43.2) |

**ALANINE** (σ Aminopropionic Acid) $CH_3CH(NH_2)COOH$.

Phenyl **ALANINE** (β Phenyl α Aminopropionic Acid) $C_6C_5.CH_2.CH(NH_2)COOH$.

### Solubility of *d. l.* Alanine and of *d. l.* Phenylalanine in Water and in Aqueous Salt Solutions at 21°. (Pfeiffer and Angern, 1924.)

The saturated solutions in water were prepared by continuous agitation at constant temperature for 3 days. The filtered solution was analyzed by the Sörensen method of titration, in which formaldehyde is added and the resulting methylene aminoacid titrated with sodium hydroxide, using phenolphthalein as indicator. The solubility in salt solutions was determined by adding the amount of salt to 5.0 cc. of the saturated solution in water necessary to yield 0.02 molecular concentration, and continuing the agitation for another 3 days. The resulting precipitate of amino acid was filtered, dried at 120-130° and its weight (after correction for inorganic salts by ashing) subtracted from the aminoacid originally present in the water.

Results for Alanine.

| Solvent. | Gms. Alanine per 100 cc. sat. sol. |
|---|---|
| Water | 13.87 |
| Aq. 0.02 molecular $CH_3COOK$. | 12.12 |
| » $(NH_4)_2SO_4$. | 11.08 |

Results for Phenylalanine

| Solvent | Gms. Phenylalanine per 100 cc. sat. sol. |
|---|---|
| Water | 1.49 |
| Aq. 0.02 molecular $CH_3COOK$. | 1.24 |
| » NaCl | 1.20 |
| » $(NH_4)_2SO_4$. | 0.59 |

**ALANINE** (α Aminopropionic Acid) $CH_3CH(NH_2)COOH$.

### Solubility in Mixtures of Alcohol and Water at 25°.

(Holleman and Antusch, 1894.)

| Vol. % Alcohol. | Gms. per 100 Gms. Solvent. | Sp. Gr. of Solutions. | Vol. % Alcohol. | Gms. per 100 Gms. Solvent. | Sp. Gr. of Solutions. |
|---|---|---|---|---|---|
| 0 | 16.47 | 1.0421 | 35 | 4.91 | 0.9670 |
| 5 | 14.37 | 1.0311 | 40 | 3.89 | 0.9577 |
| 10 | 12.43 | 1.0280 | 50 | 2.38 | 0.9355 |
| 15 | 10.49 | 1.0101 | 60 | 1.57 | 0.9102 |
| 20 | 8.48 | 0.9984 | 70 | 0.85 | 0.8836 |
| 25 | 7.11 | 0.9886 | 80 | 0.37 | 0.8556 |
| 31 | 5.53 | 0.9761 | | | |

The following additional results at 25° are given by Cohn, McMeekin, Edsall and Weare, 1934.

| Wt. Percent $C_2H_5OH$ in Aqueous Solvent | d. of sat. sol. | Gm. Mols. $C_3H_2O_2N$ per liter |
|---|---|---|
| 0.0 | 1.0432 | 1.660 |
| 5.0 | 1.0320 | 1.460 |
| 10.0 | 1.0211 | 1.250 |

### Solubility of dl Alanine in Aqueous Solutions of Ethyl Alcohol at Several Temperatures.

(Dunn and Ross, 1938.)

| t° | Vol. Percent $C_2H_5OH$ in Aq. Solvent | d. of sat. sol. | Gms. $C_3H_7O_2N$ per 100 gms. Solvent | t° | Vol. Percent $C_2H_5OH$ in Aq. Solvent | d. of sat. sol. | Gms. $C_3H_7O_2N$ per 100 gms. Solvent |
|---|---|---|---|---|---|---|---|
| 0 | 24.93 | 0.979 | 3.84 | 45.16 | 25.28 | 0.989 | 10.6 |
| " | 50.10 | 0.934 | 1.16 | 44.96 | 50.10 | 0.928 | 4.25 |
| " | 74.50 | 0.880 | 0.305 | 44.98 | 74.20 | 0.856 | 0.949 |
| " | 95.14 | 0.817 | 0.0167 | 45.19 | 95.14 | 0.794 | 0.0545 |
| 24.97 | 24.93 | 0.984 | 7.09 | 64.96 | 24.93 | 0.994 | 15.9 |
| " | 50.10 | 0.929 | 2.52 | " | 50.10 | 0.922 | 6.68 |
| " | 74.20 | 0.868 | 0.573 | " | 74.20 | 0.847 | 0.847 |
| 25.09 | 95.14 | 0.807 | 0.0329 | 64.15 | 95.09 | 0.780 | 0.780 |

### Distribution of dl-Alinine Between Water and Butyl Alcohol at 25°.

(England and Cohn, 1935.)

| Gm. Mols. $C_3H_7O_2N$ per liter | | (2)/(1) |
|---|---|---|
| $H_2O$ layer (1) | alcohol layer (2) | |
| 0.174 | 0.0041 | 0.0237 |
| 0.454 | 0.0090 | 0.0198 |
| 0.769 | 0.0163 | 0.0212 |
| 1.316 (sat.) | 0.0198 | 0.0150 |

100 gms. Pyridine dissolve 0.16 gm. Alanine at 20-25°. (Dehn, 1917.)

## β Alanine $NH_2CH_2CH_2COOH$.

### Solubility of β Alanine in Aqueous Solutions of Ethyl Alcohol at 25°.

(McMeekin, Cohn and Weare, 1936.)

| Wt. Percent $C_2H_5OH$ IN Aq. Solvent | d. of sat. sol. | Gm. Mols. $C_3H_7O_2N$ per liter | Wt. Percent $C_2H_5OH$ in Aq. Solvent | d. of sat. sol. | Gm. Mols. $C_3H_7O_2N$ per liter |
|---|---|---|---|---|---|
| 0.0(= $H_2O$) | 1.1581 | 6.123 | 60.0 | 0.9596 | 1.687 |
| 5.0 | 1.1509 | 5.827 | 70.0 | 0.9086 | 0.814 |
| 10.0 | 1.1416 | 5.620 | 80.0 | 0.8638 | 0.242 |
| 20.0 | 1.1361 | 5.180 | 90.0 | 0.8271 | 0.0382 |
| 40.0 | 1.0520 | 3.531 | 100.0 | 0.7856 | 0.00189 |

**SARCOSINE** (N-Methyl glycine) $\begin{matrix}COOH\\CH_2NHCH_3\end{matrix}$ or $\begin{matrix}COO\\CH_2NH_2CH_3\end{matrix}$

100 cc. sat. solution of sarcosine in water contain 42.82 gms. of the compound at 20°.

100 cc. sat. solution of sarcosine in aqueous 0.02 molecular $CH_3$ CO OK solution contain 36.47 gm. of the compound at 20°. (See Alanine, p. 199 for details as to the manner in which the determinations were made.) (Pfeiffer and Angern, 1924.)

Freezing-point data for mixtures of SARCOSINE ANHYDRIDE and veronal are given by Pfeiffer and Angern, 1926.

Freezing-point data are given for mixtures of Sarcosine Anhydride, $(CH_3N\ CH_2CO)_2O$, and each of the following compounds: See also p. 430

m Amino benzoic acid(3)
p " " " (1)
" " " " methyl ester(3)
6 Amino, 3.4 dimethyl azobenzene(4)
Anisic acid(4)
Anthranilic acid(1)(3)
Barbital(2)
Barbituric acid(6)
Benzoic acid(4)(7)
Carbazole(3)
Chloral hydrate(5)
Cholesterol(5)
p Dimethyl amino benzoic acid(3)
n Dimethyl indole(3)
p Iodo biphenyl(9)
Di phenyl amine(2)(3)
Indole(3)
Mannite(5)
Menthol(2)
o Methoxy benzoic acid(4)
α Methyl indole(3)(8)
β Methyl indole(3)
Methyl amino benzoic acid(3)
n Methyl phenyl voluntal(5)
n Methyl veronal(6)
2-Naphthylamine(3)
Oxindole(3)
Oxybenzoic acid(4)
Phenobarbital (Luminal)(6)
n Phenyl urethan(5)
n Phenyl voluntal(5)
n Phenyl veronal(6)
o Phenylene diamine(3)
m " " (3)
Skatol(1)
p Toluyl acid(4)
2.3.5 Trimethyl pyurol carbonic acid ethyl ester(3)
p,p';p" Tri nitro tri methyl methane(2)
Tri phenyl methane(2)
Urethan(5)
Veronal (c-Diethyl barbituric acid(2)

(1) Pfeiffer and Angern, 1925; (2) Pfeiffer and Angern, 1926; (3) Pfeiffer, Angern and Wang, 1927; (4) Pfeiffer, Angern, Wang, Seydel and Quehl, 1930; (5) Pfeiffer and Seidel, 1928; (6) Pfeiffer and Seydel 1928a; (7) Hammick and Howard, 1932; (8) Miers and Isaac, 1930; (9) Pfeiffer, Schmitz and Inoue, 1929.

**LACTAMIDE** (d) and (l) $CH_3CHOHCONH_2$.

Freezing-point data are given by Timmermans, van Lancker and Jaffe, 1939, for the following mixtures:

(d) lactamide + (l) lactamide; (d) lactamide + dichloro succinic acid; (d) lactamide + (d) dichloro succinic acid; (d) lactamide + d phenyl glycolic acid; (l) lactamide + d phenyl glycolic acid

## URETHAN (Ethyl Carbamate) $NH_2.CO_2.C_2H_5$.

### Solubility of Urethan in Several Solvents.

(Speyers, 1902)

#### Solubility in Water.

| t° | Wt. of 1 cc. sat. sol. | Mols. $NH_2.CO.C_2H_5$ per 100 mols. sat. sol. | Gms. $NH_2.CO.C_2H_5$ per 100 gms. $H_2O$. |
|---|---|---|---|
| 0..... | 1.023 | 3.61 | 18.5 |
| 10..... | 1.033 | 6.00 | 31.0 |
| 15..... | 1.043 | 15.00 | 100 |
| 20..... | 1.060 | 31.0 | 240 |
| 25..... | 1.073 | 50.0 | 480 |
| 30..... | 1.078 | 65.0 | 1370 |
| 40..... | 1.065 | 77.0 | Ca. 2200 |

#### Solubility in Methyl Alcohol.

| Wt. of 1 cc. sat. sol. | Mols. $NH_2.CO.C_2H_5$ per 100 mols. sat. sol. | Gms. $NH_2.CO.C_2H_5$ per 100 gms. $CH_3OH$. |
|---|---|---|
| 0.956 | 31.18 | 126 |
| 0.977 | 41.0 | 190 |
| 0.989 | 47.5 | 240 |
| 1.000 | 54.5 | 330 |
| 1.013 | 62.5 | 500 |
| 1.024 | 72.0 | 850 |
| 1.045 | 89.0 | 2250 |

#### Solubility in Ethyl Alcohol.

| t°. | Wt. of 1 cc. sat. sol. | Mols. $NH_2.CO.C_2H_5$ per 100 mols. sat. sol. | Gms. $NH_2.CO.C_2H_5$ per 100 gms. $C_2H_5OH$. |
|---|---|---|---|
| 0..... | 0.891 | 23.91 | 76 |
| 10..... | 0.930 | 36.0 | 120 |
| 15..... | 0.950 | 43.0 | 150 |
| 20..... | 0.968 | 50 0 | 200 |
| 25..... | 0.985 | 59.0 | 280 |
| 30..... | 1.001 | 70.0 | 430 |
| 40..... | 1.035 | 88.0 | 1300 |

#### Solubility in Propyl Alcohol.

| Wt. of 1 cc. sat. sol. | Mols. $NH_2.CO.C_2H_5$ per 100 mols. sat. sol. | Gms. $NH_2.CO.C_2H_5$ per 100 gms. $C_3H_7OH$. |
|---|---|---|
| 0.880 | 19.48 | 35 |
| 0.906 | 31.0 | 66 |
| 0.923 | 40.0 | 105 |
| 0.942 | 51.0 | 150 |
| 0.963 | 60.0 | 220 |
| 0.983 | 68.0 | 317 |
| 1.025 | 85.0 | 820 |

#### Solubility in Chloroform

| t°. | Wt. of 1 cc. sat. sol. | Mols. $NH_2.COC_2H_5$ per 100 mols. sat. sol. | Gms. $NH_2CO\,C_2H_5$ per 100 gms. $CHCl_3$. |
|---|---|---|---|
| 0..... | 1.404 | 27.56 | 28.4 |
| 10..... | 1.340 | 41 | 53 |
| 15..... | 1.310 | 46 | 65 |
| 20..... | 1.280 | 53 | 85 |
| 25..... | 1.240 | 60 | 117 |
| 30..... | 1.203 | 67 | 162 |
| 40..... | 1.125 | 80 | 282 |

#### Solubility in Toluene

| Wt. of 1 cc. sat. sol. | Mols. $NH_2.CO.C_2H_5$ per 100 mols. sat. sol. | Gms. $NH_2.CO.C_2H_5$ per 100 gms. $C_6H_5CH_3$. |
|---|---|---|
| 0.887 | 1.77 | 1.7 |
| 0.874 | 5.0 | 6 |
| 0.875 | 10.0 | 10 |
| 0.883 | 16.0 | 18 |
| 0.902 | 25.0 | 45 |
| 0.927 | 44.0 | 95 |
| 0.995 | 85.0 | 620 |

100 gms. quinoline dissolve 9.72 + gms. Urethan at 20-25°. (Pucher and Dehn, 1921.)

100 gms. sat. solution of **Methyl Urethan** in Water contain about 69.0 gms. $NH_2.CO.CH_3$ at 15°.5.

100 gms. sat. solution of **Propyl Urethan** in Water contain about 7.7 gms. $NH_2.CO.C_3H_7$ at 15°.5. (Führer, 1924.)

100 gms. sat. solution of Ethyl Urethan in Water contain 48 gms. $NH_2COOC_2H_5$ at 15.5°. (Führer, 1924.)

### Freezing-points of Mixtures of Urethan and Water.

(Chadwell and Politi, 1938.)

| t° of freezing | Gm. Mols. $NH_2COOC_2H_5$ per 1000 gms. $H_2O$ | Solid Phase | t° of freezing | Gm. Mols. $NH_2COOC_2H_5$ per 1000 gms. $H_2O$ | Solid Phase |
|---|---|---|---|---|---|
| -0.4642 | 0.2568 | Ice | -1.7176 | 1.0377 | Ice |
| -0.6863 | 0.3840 | " | -1.8122 | 1.1320 | " |
| -0.8426 | 0.4766 | " | -1.9444 | 1.1935 | " |
| -1.1885 | 0.6895 | " | -2.6887 (Eutec.) | 1.7609 | " + $NH_2COOC_2H_5$ |

## Solubility of Urethan in Aqueous Salt Solutions at 25°.

(Palitzsch, 1929.)

In aqueous solutions of:

| Sodium Chloride | | Potassium Chloride | |
|---|---|---|---|
| Gm. Mols. NaCl per liter aq. solvent | Gms. $NH_2COOC_2H_5$ per liter sat. sol. | Gm. Mols. KCl per liter aq. solvent | Gms. $NH_2COOC_2H_5$ per liter sat. sol. |
| 0.0 (= $H_2O$) | 875. | 0.0 (= $H_2O$) | 875.0 |
| 2.20 | 217.8 | 2.20 | 275.6 |
| 3.21 | 51.9 | 3.84 | 39.7 |

100 gms. sat. solution in liquid $CO_2$ contain 4 gms. urethan at the critical temperature, 23.5°; at 30.5° the mixture separates with two layers. (Büchner, 1905–06.)

100 gms. pyridine dissolve 21.32 gms. urethan at 20–25°. (Dehn, 1917.)
100 gms. aq. 50% pyridine dissolve 101.1 gms. urethan at 20–25°. "

## Solubility of Urethan Derivatives in Water.

(Odaira, 1915.)

| Name. | Formula. | t°. | Gms. Cmpd. per 100 Gms. $H_2O$. |
|---|---|---|---|
| Detonal (Diethyl Aceturethan) | $(C_2H_5)_2CH.CO.NH.CO.OC_2H_5$ | ... | 0.526 |
| Epronal (Ethylpropyl Aceturethan) | $(C_2H_5)(C_3H_7)CH.CO.NH.CO.OC_2H_5$ | cold | 0.143 |
| Dipronal (Dipropyl Aceturethan) | $(C_3H_7)CH.CO.NH.CO.OC_2H_5$ | 20 | 0.040 |
| Probnal (Propylbutyl Aceturethan) | $(C_3H_7)(C_4H_9)CH.CO.NH.CO.OC_2H_5$ | 20 | 0.032 |
| Dibnal (Dibutyl Aceturethan) | $(C_4H_9)_2CH.CO.NH.CO.OC_2H_5$ | ... | 0.008 |
| Oenanthyl Urethan | $CH_3(CH_2)_5CO.NH.CO.OC_2H_5$ | ... | 0.021 |
| *n* Isoamyl Urethan | $(C_2H_5)_2CH.NH.CO.OC_2H_5$ | 20 | 0.410 |
| *α* Bromethyl Propyl Aceturea | $(C_2H_5)(C_3H_7)CBr.CO.NH.CO.NH_2$ | 20 | 0.041 |

## Distribution of Urethan Derivatives between Water and Olive Oil.

| Name. | Formula. | t°. | Gms. Cmpd. per 100 cc. $H_2O$ Layer. | Gms. Cmpd. per 100 cc. Olive Oil Layer. | Dist. Ratio $\frac{Conc._{oil}}{Conc._{H_2O}}$. |
|---|---|---|---|---|---|
| Ethyl Urethan | $NH_2COOC_2H_5$ | ord. | 4.52 | 0.615 | 0.136 (1) |
| Methyl Urethan | $NH_2COOCH_3$ | ord. | 7.50 | 0.275 | 0.037 (1) |
| Aceturethan | $CH_3CONH.COOC_2H_5$ | 17–20 | 2.94 | 0.389 | 0.132 (2) |
| Epronal | $(C_2H_5)(C_2H_7)CH.CO.NH.CO.OC_2H_5$ | " | 0.076 | 0.257 | 3.3 (2) |
| Detonal | $(C_2H_5)_2CH.CO.NH.CO.OC_2H_5$ | " | 0.122 | 0.213 | 1.8 (2) |
| | | | 0.326 | 0.549 | 1.7 (2) |
| Veronal (diethylbarbituric acid) | $CO(NHCO)_2C.(C_2H_5)_2$ | " | 0.180 | 0.020 | 0.11 (2) |
| | | | 0.268 | 0.032 | 0.12 (2) |

(1) Baum, 1899; H. von Meyer, 1909.

(2) Odaira, 1915.

Freezing-point data are given for Urethan +

Acetic Acid(21)
Mono chloro acetic acid(21)
Di " " " (21)
Tri " " " (11)(21)
Acetanilide(4)
Antipyrine(1)(2)(3)
4-di methyl amino antipyrine(1)
Antipyrine + Phenacetine(5)
" + Urea(5)(7)
" + Menthol(5)
Benzene(13)(14)(15)(19)(20)
Benzoic acid(17)
Camphor(9)
Di phenyl amine(10)(14)(15)
Di nitro benzene(18)
p Nitroso toluene(8)
p nitro toluene(8)
Erythritol(22)
Guiacol(16)
Menthol(2)(3)
Naphthalene(12)
α Nitro naphthalene(8)
p Nitro anisole(15)
Phenacetine(3)(11)
" + Urea(5)
Phenol(23)
Phenol + Urea(6)
Pyramidon(1)
Resorcinol(3)
Salicylic acid + Urea(6)
Salol(3)
Sarcosine anhydride(1)
Urea(2)(3)

(1) Pfeiffer and Seydel, 1928; (2) Adamanis, 1933; (3) Hrynokowski and Adamanis, 1933; (4) Hrynakowski and Adamanis, 1933a; (5) Hrynakowski, 1934; (6) Hrynakowski and Szmyt, 1935a; (7) Hrynakowski and Adamanis, 1935; (8) Mascarelli, 1908; (9) Migliacci and Calo, 1927; (10) Angelletti, 1928; (11) Kitran, 1924; (12) Vasilev, 1917; (13) Puschin, 1925; (14) Puschin, 1929; (15) Puschin and Grebenschikov, 1913; (16) Puschin and Vaic, 1926; (17) Puschin and Wilowitsch, 1925; (18) Puschin and Fioletova, 1922; (19) Puschin and Glagoleva, 1914; (20) Puschin and Mazarovich, 1914; (21) Puschin and Rikovsky, 1932; (22) Puschin and Dezelic, 1932; (23) Mascarelli and Pestaklozza, 1908, 1909.

β Phospho**PROPIONIC ACID** $HCOO\,C_2H_4.PO(OH)_2$ (m. pt. = 178°).
100 gms. sat. sol. in water contain 39.7 gms. of the compd. at 0° and 48.8 gms. at 20°.
(Nylen, 1926.)

dl **SERINE** $CH_2OHCH(NH_2)COOH$.

### Solubility of Serine in Water.
(Dalton and Schmidt, 1935.)

The results of 32 determinations at temperatures between 0-62° were used for calculating the solubility equation and from this the following values for 5° intervals were obtained. The values above 70° are not considered as accurate as those for the lower temperatures. Density determinations of several dilute aqueous solutions at 25° are also given.

| t° | Gms. $C_3H_7O_3N$ per 100 gms. $H_2O$ | t° | Gms. $C_3H_7O_3N$ per 100 gms. $H_2O$ | t° | Gms. $C_3H_7O_3N$ per 100 gms. $H_2O$ |
|---|---|---|---|---|---|
| 0 | 2.204 | 30 | 5.852 | 60 | 13.41 |
| 5 | 2.620 | 35 | 6.787 | 65 | 15.18 |
| 10 | 3.103 | 40 | 7.842 | 70 | 17.11 |
| 15 | 3.658 | 45 | 9.024 | 75 | 19.21 |
| 20 | 4.295 | 50 | 10.34 | 100 | 32.24 |
| 25 | 5.023 | 55 | 11.80 | | |

100 cc of Acetic acid dissolve 0.088 gm. dl Serine at 18°.
(v. Przylecki and Kasprzyk-Czarykowska, 1938.)

## SERINE $CH_2OHCH(NH_2)COOH$.

### Solubility of dl Serine in Aqueous Solutions of Ethyl Alcohol.

(Dunn and Ross, 1938.)

| t° | Wt. % $C_2H_5OH$ in aq. solvent | d. of sat. sol. | Gms. $C_3H_7O_2N$ per 100 gms. solvent | t° | Wt. % $C_2H_5OH$ in aq. solvent | d. of sat. sol. | Gms. $C_3H_7O_2N$ per 100 gms. solvent |
|---|---|---|---|---|---|---|---|
| 0 | 20.32 | 0.975 | 0.530 | 45 | 20.32 | 0.968 | 3.14 |
| " | 42.52 | 0.938 | 0.146 | " | 42.52 | 0.912 | 0.985 |
| " | 67.27 | 0.882 | 0.0304 | " | 66.94 | 0.857 | 0.185 |
| " | 92.61 | 0.818 | 0.0008 | " | 92.61 | 0.793 | 0.0058 |
| 25 | 20.32 | 0.970 | 1.54 | 65 | 20.32 | 0.974 | 5.99 |
| " | 42.52 | 0.923 | 0.461 | " | 42.52 | 0.909 | 1.88 |
| " | 67.27 | 0.869 | 0.0840 | " | 67.27 | 0.844 | 0.318 |
| " | 92.61 | 0.806 | 0.0028 | " | 92.61 | 0.783 | 0.0152 |

## PROPYL ALCOHOL $C_3H_7OH$.

Freezing-point data for mixtures of propyl alcohol and water are given by Pickering (1893).

Results for mixtures of isopropyl alcohol and water are given by Dreyer (1913)

100 gms. sat. solution of propyl alcohol in liquid carbon dioxide contain 36.5 gms. $C_3H_7OH$ at $-24°$ and 57.5 gms. at $-30°$. (Büchner, 1905–06.)

### Miscibility of Propyl Alcohol with Mixtures of Chloroform and Water at 0°.

(Bonner, 1910.)

See Notes, pp. 45 and 176

| Composition of Homogeneous Mixtures. | | | | Composition of Homogeneous Mixtures. | | | |
|---|---|---|---|---|---|---|---|
| Gms. $CHCl_3$. | Gms. $H_2O$. | Gms. $C_3H_7OH$. | Sp. Gr. of Mixture. | Gms. $CHCl_3$. | Gms. $H_2O$. | Gms. $C_3H_7OH$. | Sp. Gr. of Mixture. |
| 0.977 | 0.023 | 0.304 | 1.28 | 0.500 | 0.50 | 1.34 | 0.97 |
| 0.926 | 0.074 | 0.631 | 1.13 | 0.394 | 0.606 | 1.32 | 0.98 |
| 0.90 | 0.10 | 0.76 | 1.11 | 0.293 | 0.707 | 1.235 | 0.96 |
| 0.80 | 0.20 | 1.06 | 1.04 | 0.194 | 0.806 | 0.996 | 0.95 |
| 0.70 | 0.30 | 1.20 | 1.01 | 0.097 | 0.903 | 0.672 | 0.97 |
| 0.60 | 0.40 | 1.30 | 0.98 | 0.030 | 0.97 | 0.39 | 0.97 |

### Miscibility of Propyl Alcohol at 0° with Mixtures of:

#### Carbon Tetrachloride and Water.

(Bonner, 1910.)

| Composition of Homogeneous Mixtures. | | | |
|---|---|---|---|
| Gms. $CCl_4$. | Gms. $H_2O$. | Gms. $C_3H_7OH$. | Sp. Gr. of Mixture. |
| 0.975 | 0.025 | 0.317 | 1.31 |
| 0.931 | 0.069 | 0.536 | 1.17 |
| 0.90 | 0.10 | 0.65 | 1.14 |
| 0.80 | 0.20 | 0.949 | 1.07 |
| 0.70 | 0.30 | 1.12 | 1.02 |
| 0.60 | 0.40 | 1.20 | 0.99 |
| 0.499 | 0.501 | 1.234 | 0.98 |
| 0.40 | 0.60 | 1.195 | 0.97 |
| 0.30 | 0.70 | 1.13 | 0.96 |
| *0.25 | 0.75 | 1.06 | ... |
| 0.194 | 0.806 | 0.912 | 0.96 |
| 0.100 | 0.90 | 0.68 | 0.96 |
| 0.013 | 0.987 | 0.354 | 0.96 |

#### Ethyl Bromide and Water.

(Bonner, 1910.)

| Composition of Homogeneous Mixtures. | | | |
|---|---|---|---|
| Gms. $C_2H_5Br$. | Gms. $H_2O$. | Gms. $C_3H_7OH$. | Sp. Gr. of Mixture. |
| 0.941 | 0.039 | 0.367 | 1.21 |
| 0.912 | 0.088 | 0.615 | 1.11 |
| 0.90 | 0.10 | 0.64 | 1.10 |
| 0.80 | 0.20 | 0.85 | 1.05 |
| 0.70 | 0.30 | 1 | 1.02 |
| 0.60 | 0.40 | 1.09 | 1 |
| 0.491 | 0.509 | 1.124 | 0.98 |
| 0.40 | 0.60 | 1.10 | 0.97 |
| 0.30 | 0.70 | 0.90 | 0.96 |
| 0.20 | 0.80 | 0.81 | 0.96 |
| 0.14 | 0.86 | 0.671 | 0.96 |
| 0.10 | 0.90 | 0.56 | 0.97 |
| *0.023 | 0.977 | 0.227 | 0.99 |

### Miscibility of Propyl Alcohol at 0° with Mixtures of:

Bromobenzene and Water. (Bonner, 1910.)

Composition of Homogeneous Mixtures.

| Gms. $C_6H_5Br$. | Gms. $H_2O$. | Gms. $C_3H_7OH$. | Sp. Gr. of Mixture. |
|---|---|---|---|
| 0.983 | 0.017 | 0.186 | 1.29 |
| 0.909 | 0.091 | 0.56 | 1.11 |
| 0.90 | 0.10 | 0.58 | 1.11 |
| 0.80 | 0.20 | 0.87 | 1.05 |
| 0.70 | 0.30 | 1.05 | 1.02 |
| 0.60 | 0.40 | 1.15 | 1 |
| 0.50 | 0.50 | 1.19 | 0.97 |
| 0.40 | 0.60 | 1.19 | 0.97 |
| 0.30 | 0.70 | 1.09 | 0.95 |
| 0.20 | 0.80 | 0.93 | 0.95 |
| 0.10 | 0.90 | 0.71 | 0.96 |
| 0.021 | 0.979 | 0.457 | 0.98 |

Bromotoluene and Water. (Bonner, 1910.)

Composition of Homogeneous Mixtures.

| Gms. $C_6H_4CH_3Br$. | Gms. $H_2O$. | Gms. $C_3H_7OH$. | Sp. Gr. of Mixture. |
|---|---|---|---|
| 0.968 | 0.032 | 0.252 | 1.23 |
| 0.90 | 0.10 | 0.52 | 1.11 |
| 0.80 | 0.20 | 0.78 | 1.03 |
| 0.70 | 0.30 | 0.96 | 1.01 |
| 0.60 | 0.40 | 1.07 | 0.99 |
| 0.50 | 0.50 | 1.13 | 0.97 |
| 0.40 | 0.60 | 1.13 | 0.96 |
| 0.30 | 0.70 | 1.03 | 0.95 |
| *0.25 | 0.75 | 0.97 | ... |
| 0.20 | 0.80 | 0.90 | 0.94 |
| 0.10 | 0.90 | 0.72 | 0.95 |
| 0.013 | 0.987 | 0.424 | 0.96 |

See Notes, pp. 45 and 176

### Distribution of Propyl Alcohol between Water and Cotton-seed Oil at 25°.

(Wroth and Reid, 1916.)

| Gms. $C_3H_7OH$ per 100 cc. | | Ratio. | Gms. $C_3H_7OH$ per 100 cc.: | | Ratio. |
|---|---|---|---|---|---|
| Oil Layer. | $H_2O$ Layer. | | Oil Layer. | $H_2O$ Layer. | |
| 1.447 | 8.112 | 5.60 | 1.516 | 10.07 | 6.64 |
| 1.475 | 8.897 | 6.10 | 1.576 | 10.49 | 6.65 |
| 1.503 | 9.809 | 6.53 | 1.694 | 10.41 | 6.14 |

Data for systems composed of normal propyl alcohol, water and various inorganic salts are given by Timmermans, 1907.

### Equilibrium in the System Iso Propyl Alcohol, Benzene and Water at 19°.

(Perrakis, 1925.)

The amount of water required to produce clouding in various mixtures of iso propyl alcohol and benzene was determined.

| Gms. $C_3H_7OH$ per 100 gms. $C_3H_7OH$ + $C_6H_6$ Mixture | Gms. $H_2O$ to cause clouding in 100 gms. of Mixture | Gms. $C_3H_7OH$ per 100 gms. $C_3H_7OH$ + $C_6H_6$ Mixture | Gms. $H_2O$ to cause clouding in 100 gms. of Mixture |
|---|---|---|---|
| 13.22 | 0.8897 | 33.53 | 4.7646 |
| 19.46 | 1.6493 | 34.84 | 5.3381 |
| 24.60 | 2.3165 | 36.10 | 5.8770 |
| 28.20 | 2.9408 | 37.43 | 6.4164 |
| 30.96 | 3.5283 | 43.61 | 9.2394 |
| 32.31 | 4.1593 | | |

## Equilibrium in the System Normal Propyl Alcohol, Iso Amyl Alcohol and Water at 25°.

(Coull and Hope, 1935.)

The binodal curve was determined by titrating 200 cc mixtures of normal propyl and iso amyl alcohol with water to first appearance of turbidity.

| Vol. percent composition of the homogeneous mixtures | | | Vol. percent composition of the homogeneous mixtures | | |
|---|---|---|---|---|---|
| Iso Amyl Alcohol | n Propyl Alcohol | Water | Iso Amyl Alcohol | n Propyl Alcohol | Water |
| 93.32 | 0.0 | 6.68 | 25.10 | 46.59 | 28.31 |
| 89.90 | 2.30 | 9.22 | 19.80 | 46.21 | 33.99 |
| 86.83 | 4.57 | 8.60 | 13.77 | 41.32 | 44.91 |
| 81.37 | 9.04 | 9.59 | 8.60 | 34.40 | 57.00 |
| 71.10 | 17.78 | 11.12 | 4.08 | 23.98 | 71.99 |
| 60.84 | 26.08 | 13.08 | 2.53 | 19.49 | 77.98 |
| 50.63 | 33.76 | 15.61 | 2.25 | 14.66 | 83.09 |
| 45.47 | 37.21 | 17.32 | 2.29 | 9.77 | 87.94 |
| 40.40 | 40.40 | 19.20 | 2.44 | 4.88 | 92.68 |
| 35.02 | 42.81 | 22.17 | 3.10 | 0.0 | 96.90 |
| 30.17 | 45.26 | 24.57 | | | |

The authors also determined the densities and refractive indices of various mixtures of the three liquids. From the latter values a diagram was constructed showing the location of the tie lines connecting the compositions of layers in contact with each other.

## Equilibrium in the System Iso Propyl Alcohol, Benzene and Water at 25°.

(Olsen and Washburn, 1935.)

The binodal curve was determined by the titration method. Results are also given for the refractive indices, relative viscosities and densities of the homogeneous mixtures.

| Gms. per 100 gms. homogeneous mixture | | | d. of mixture | Gms. per 100 gms. homogeneous mixture | | | d. of mixture |
|---|---|---|---|---|---|---|---|
| $C_6H_6$ | i Propyl alc. | $H_2O$ | | $C_6H_6$ | i Propyl alc. | $H_2O$ | |
| 99.93 | 0.0 | 0.07 | 0.8733 | 27.17 | 51.36 | 21.47 | 0.8543 |
| 87.74 | 13.20 | 0.06 | 0.8594 | 23.63 | 50.42 | 25.95 | 0.8619 |
| 82.06 | 17.22 | 0.72 | — | 17.59 | 48.16 | 34.25 | 0.8771 |
| 68.63 | 28.54 | 2.83 | 0.8467 | 8.71 | 41.79 | 49.50 | 0.9084 |
| 57.81 | 37.95 | 4.24 | 0.8392 | 6.25 | 39.11 | 54.64 | 0.9165 |
| 44.55 | 46.00 | 9.46 | 0.8405 | 2.21 | 32.51 | 65.28 | 0.9386 |
| 35.30 | 50.28 | 14.42 | 0.8442 | 0.80 | 25.16 | 74.04 | 0.9571 |
| 29.40 | 51.00 | 19.59 | 0.8516 | 0.15 | 0.0 | 99.85 | 0.9974 |

In order to locate the tie lines mixtures were prepared which separated into two layers and the alcohol in each of these determined by the refracto- meter. These results permitted drawing a diagram showing distribution of the alcohol between water and benzene, the composition of the layers in contact with each other.

RECIPROCAL SOLUBILITY OF PROPYL ALCOHOL AND BENZENE.
(Wieth, 1929.)

| $t^0$ | Wt. % $C_6H_6$ in sat. sol. | $t^0$ | Wt. % $C_6H_6$ in sat. sol. |
|---|---|---|---|
| -9 | 33.7 | -1.2 | 59.4 |
| -4.4 | 45.1 | -0.3 | 64.7 |
| -3.6 | 48.1 | +0.8 | 71.8 |
| -2.3 | 53.6 | | |

Freezing-point data for mixtures of Propyl Alcohol and Acetic Acid are given by Pickering, 1893.

## METHYLAL $HCH(OCH_3)_2$.

RECIPRODAL SOLUBILITY OF METHYLAL AND WATER. (Bourgom, 1924.)

The methylal was purified by distilling over sodium. It had a b. pt. of 142°.3 at 760 mm.

The determinations were made by the freezing-point method and by the synthetic method.

| $t^\circ$ of f. pt. | Gms. $HCH(OCH_3)_2$ per 100 gms. sat. sol. | $t^\circ$ of f. pt. | Gms. $HCH(OCH_3)_2$ per 100 gms. sat. sol | $t^\circ$ of homogeneity. | Gms. $HCH(OCH_3)_2$ per 100 gms. sat. sol. |
|---|---|---|---|---|---|
| —1.35..... | 5.26 | — 10.78.... | 33.60 | 148.9..... | 37.23 |
| —2.77..... | 10.11 | — 11.0 (tr. pt.) | 34.4 | 154.0..... | 40.16 |
| —3.31..... | 11.79 | — 11.0..... | 36.23 | 159.8..... | 50.46 |
| —3.54..... | 12.66 | » ..... | 42.98 | 159.9..... | 50.64 |
| —4.54..... | 15.73 | » ..... | 54.17 | 160.2..... | 55.84 |
| —4.98..... | 17.44 | » ..... | 68.12 | 160.3..... | 57.34 |
| —5.79..... | 19.15 | » ..... | 85.58 | 160.2..... | 58.04 |
| —6.38..... | 20.60 | » ..... | 95.72 | 159.5..... | 65.39 |
| —7.54..... | 23.12 | — 11 (tr. pt.).. | 97.5 | 157.5..... | 72.45 |
| —8.10..... | 25.20 | — 12.8..... | 97.53 | 104.5..... | 86.90 |
| —8.60..... | 25.52 | — 15.5..... | 97.9 | 55.0..... | 91.08 |
| —9.80..... | 29.98 | —104.8(m. pt).) | 100.00 | | |

The two liquid layers in contact at 16° were found to have respectively :

Lower layer (aqueous), $d_{16} = 0.98427$ and contains 32.3 gms. $HCH(OCH_3)_2$ } per 100 gms.
Upper layer (methylal), $d_{16} = 0.87636$ » 95.7 » } sat. sol.

Freezing-point data are given for mixtures of:

Methylal + Carbon Disulfide (Sapgir, 1929.)
" + Ethylal " "
" + Ethyl Ether (Timmermans, 1934.)

## PROPYLAMINE $CH_3.CH_2.CH_2.NH_2$.

The solubility of propylamine in water at 60°, determined by an aspiration method using an indifferent gas, is 191 when expressed in terms of the Bunsen absorption coefficient $\beta$ (see p. 37 ) and $l_{60} = 233$ when expressed in terms of the Ostwald solubility expression. (Doyer, 1890.)

## DIMETHYL UREA s, and as $C_3H_8N_2O$.

Freezing-point data for mixtures of dimethyl urea and phenol are given by Kremann, 1910.

**ETHYL UREA** $NH_2CONHC_2H_5$.

100 gms. abs. Ethyl Alcohol dissolve 79.95 gms. $C_3H_8N_2O$ at 20-25°.
" " Quinoline " 1.13 " " " "
" " + Alcohol " 5.51 " " " "
(Pucher and Dehn, 1921.)

**β METHOXY ETHANOL** (Methyl Cellosolve) $CH_3OCH_2CH_2OH$.

The critical solution temperature of mixtures of β Methoxy Ethanol and n Heptane is 47.5°. (Cornish, Archibald, Murphy and Evans, 1934.)

These authors also give similar results for mixtures of β Methoxy Ethanol and i Octane.

**GLYCEROL** $CH_2OH.CHOH.CH_2OH$.

RECIPROCAL SOLUBILITY OF GLYCEROL AND WATER, DETERMINED BY THE FREEZING-POINT METHOD. (Lane, 1925.)

| t° of f. pt. | Gms. $C_3H_5(OH)_3$ per 100 gms. sat. sol. | t° of f. pt. | Gms. $C_3H_5(OH)_3$ per 100 gms. sat. sol. | t° of f. pt. | Gms. $C_3H_5(OH)_3$ per 100 gms. sat. sol. |
|---|---|---|---|---|---|
| — 0.6..... | 5.0 | —23.0..... | 50.0 | —45.5..... | 67.1 |
| — 1.6..... | 10.0 | —28.2..... | 55.0 | —44.5..... | 69.3 |
| — 3.1..... | 15.0 | —34.7..... | 60.0 | —38.9..... | 70.0 |
| — 4.8..... | 20.0 | —41.5..... | 64.0 | —29.8..... | 75.0 |
| — 7.0..... | 25.0 | —42.5..... | 64.7 | —20.3..... | 80.0 |
| — 9.5..... | 30.0 | —43.0..... | 65.0 | —10.9..... | 85.0 |
| —12.2..... | 35.0 | —44.5..... | 65.6 | — 1.6..... | 90.0 |
| —15.4..... | 40.0 | —44.7..... | 66.0 | + 7.7..... | 95.0 |
| —18.8..... | 45.0 | —46.5(Eutec.). | 66.7 | 17.0..... | 100.0 |

The temperatures given as the freezing-points were those at which crystals appeared and continued to grow. On account of the tendency of glycerol to supercool, seeding was required to obtain true freezing-points of all the more concentrated solutions, beginning at the eutectic point.

Data for this system are also given by Pushin and Glagoleva, 1922, but their results agree with those of Lane only in the region of the higher concentrations of glycerol. They report the eutectic at —31° and 20 mol. per cent (= 57.62 wt. per cent) glycerol, and their other points are evidently incorrect.

RECIPROCAL SOLUBILITY OF GLYCEROL AND PYROCATECHOL.
(Parvatiker and Mc Ewen, 1924.)

| t° of miscibility... | 183°. | 192°. | 192.8°. | 192.9. | 191° | 172.5°. |
|---|---|---|---|---|---|---|
| Wt. % pyrocatechol.... | 79.37 | 63.71 | 48.68 | 44.42 | 35.3 | 20.05 |

RECIPROCAL SOLUBILITY OF GLYCEROL AND GUAIACOL. (Mc Ewen, 1923.)

This system gives a solubility curve which is a complete circle.

| t° of solution No separation between: | | | Gms. Guaicol per 100 gms. mixture. |
|---|---|---|---|
| 35° | and | 80° | 28.57 |
| 73.5 | » | 46.6..... | 31.88 |
| 80.1 | » | 42.2..... | 38.82 |
| 80.4 | » | 41.8..... | 39.04 |
| 82.6 | » | 40.7*..... | 46.18 |
| 83.4* | » | 39.8*..... | 54.56 |
| 83.5* | » | 39.5..... | 59.87 |

| t° of solution No separation between: | | | Gms. Guaicol per 100 gms. mixture. |
|---|---|---|---|
| 83.0°* | and | 39.9°..... | 61.35 |
| 83.0* | » | 39.9..... | 61.93 |
| 79.5 | » | 42.0..... | 68.02 |
| 72.9 | » | 47.0..... | 73.03 |
| 67.0 | » | 51.5..... | 74.72 |
| 66.0 | » | 52.5..... | 75.22 |
| 35.0 | » | 90.0..... | 77.40 |

* Indicates critical opalescence.

RECIPROCAL SOLUBILITY OF GLYCEROL AND SALICYLALDEHYDE. (Mc Ewen, 1923.)

| t° of solution. | Gms. Salicylaldehyde per 100 gms. mixture. | t° of solution. | Gms. Salicylaldehyde per 100 gms. mixture. |
|---|---|---|---|
| 91.5..... | 5.36 | 176.6..... | 52.22 |
| 148.5..... | 18.30 | 176.5..... | 58.67 |
| 165.5..... | 26.54 | 170.5..... | 77.02 |
| 175.5..... | 41.82 | 143.5..... | 91.38 |
| 176.5..... | 48.32 | 106.5..... | 95.60 |

RECIPROCAL SOLUBILITY OF GLYCEROL AND : (Parvatiker and Mc Ewen, 1924.)

*o* Toluidine.

| t° of miscibility. | Gms. *o* $C_6H_4CH_3.NH_2$ per 100 gms. mixture. |
|---|---|
| 100..... | 92 2 |
| 130..... | 86.14 |
| 150..... | 73.42 |
| 154..... | 63.28 |
| 154.4..... | 52.53 |
| 154..... | 46.59 |
| 153..... | 40.97 |
| 150..... | 32.04 |
| 137..... | 20.96 |
| 99.2..... | 12.42 |

*m* Toluidine.

| t° of miscibility. | Gms. *m* $C_6H_4CH_3.NH_2$ per 100 gms. mixture. |
|---|---|
| 89..... | 83.23 |
| 102..... | 79.23 |
| 113.5..... | 71.58 |
| 119.4..... | 64.30 |
| 120.5..... | 58.68 |
| 120.2..... | 53.10 |
| 119.5..... | 45.68 |
| 117.5..... | 36.87 |
| 88.5..... | 18.71 |
| upper half of circle | |

| t° of miscibility. | Gms. *m* $C_6H_4CH_3.NH_2$ per 100 gms. mixture. |
|---|---|
| 33.4..... | 83.62 |
| 7.8..... | 66.04 |
| 7.0..... | 62.86 |
| 6.7..... | 48.80 |
| 8.2..... | 40.99 |
| 9.2..... | 31.40 |
| 14.2..... | 21.68 |
| 16.8..... | 18.72 |
| 23.0..... | 13.99 |
| lower half of circle | |

CRITICAL SOLUTION TEMPERATURES OF MIXTURES OF GLYCEROL AND OTHER SOLVENTS.

(Lecat, 1930.)

| System | Critical Solution Temp. | Wt. Percent Glycerol in mixture |
|---|---|---|
| Glycerol + Ethyl phenyl acetate | 81 | 7.0 |
| " + Ethyl salicylate | > 226 | 10.0 |
| " + Bornyl acetate | 200 | 9.0 |
| " + i Butyl benzoate | 230 | 14.0 |
| " + n " " | 242 | 17.0 |
| " + Eugenol | 166 | 14.0 |
| " + Methyl Salicylate | 170 | 7.5 |
| " + o Nitro toluene | 193 | 8.0 |
| " + p " " | 220 | 17.0 |

100 gms. liquid Carbon Dioxide dissolve less than 0.05 gm. glycerol, Quinn, 1928.

Freezing-point data are given by Puschin and Dezelic, 1932, for mixtures of Glycerol and Oleic, Palmitic and Stearic Acids.

## TRI METHYL AMINE $(CH_3)_3N$.

Freezing-point data for mixtures of tri methyl amine and water are given by Pickering, 1893.

## Solubility of Trimethyl Amine in Various Solvents at 25°.

(v. Halban, 1913.)

The measurements were made according to the dynamic method in the form developed by R. Abegg and his collaborators (Gaus, 1900; Abegg and Riesenfeld, 1902). The calculations of the partial pressures of the trimethylamine were made according to the Abegg and Riesenfeld method.

$E$ = calc. partial pressure of $(CH_3)_3N$ above a 1 normal solution, based on Henry's Law.

$\lambda$ = solubility, *i.e.*, the quotient of the concentration in the solution and in the gas phase: $\lambda = \frac{\text{mols. } (CH_3)_3N \text{ per liter} \times RT \times 760}{\text{partial pressure of } (CH_3)_3N \text{ in mm. Hg}}$, $RT \times 760 = 18{,}590$.

| Solvent. | *E.* | λ. | Solvent. | *E.* | λ. | Solvent. | *E.* | λ. |
|---|---|---|---|---|---|---|---|---|
| Methyl Alc. | 26.1 | 711 | Acetophenone | 321 | 57.9 | Ethyl Acetate | 220 | 84.5 |
| Ethyl " | 39.5 | 471 | Ether | 349 | 53.3 | Ethyl Benzoate | 244 | 76.2 |
| Propyl " | 39.4 | 472 | Acetonitrile | 292 | 63.7 | Chloroform | 31.1 | 598 |
| Amyl " | 48.3 | 385 | Nitromethane | 329 | 56.5 | α Bromnaphthalene | 409 | 47 |
| Benzyl " | 14.2 | 1308 | *o* Nitrotoluene | 340 | 54.7 | Hexane | 248 | 75 |
| Acetone " | 243 | 76.7 | Nitrobenzene | 350 | 53.1 | Benzene | 172 | 109 |

Two determinations are also given for triethyl amine:

$\lambda_{25}$ in hexane = 2160. $\lambda_{25}$ in nitromethane = 400.

## Distribution of Trimethyl Amine at 25° Between : (Smith, 1921, 1922.)

### Water and Chloroform.

| Millimols. $(CH_3)_3N$ per liter of | | |
|---|---|---|
| $H_2O$. layer ($C_1$). | $CHCl_3$ layer ($C_2$). | $\frac{C_2}{C_1}$. |
| 0.30 | 0.70 | 2.33 |
| 0.60 | 1.50 | 2.50 |
| 1.05 | 2.90 | 2.62 |
| 4.85 | 14.95 | 3.08 |

### Water and Ether.

| Millimols. $(CH_3)_3N$ per liter of | | |
|---|---|---|
| $H_2O$ layer ($C_1$). | $(C_2H_5)_2O$ layer ($C_2$). | $\frac{C_2}{C_1}$. |
| 0.800 | 1.2125 | 0.660 |
| 1.1625 | 1.775 | 0.655 |
| 1.775 | 2.65 | 0.67 |
| 3.00 | 4.45 | 0.675 |
| 6.30 | 8.90 | 0.707 |

### Water and Xylene.

| Millimols. $(CH_3)_3N$ per liter of | | |
|---|---|---|
| $H_2O$ layer ($C_1$). | $C_6H_4(CH_3)_2$ layer ($C_2$). | $\frac{C_2}{C_1}$. |
| 2.13 | 1.00 | 0.47 |
| 2.775 | 1.225 | 0.442 |
| 6.97 | 3.03 | 0.435 |
| 14.22 | 5.78 | 0.407 |

## Distribution of Tri Methyl Amine Between Water and Toluene.

(Moore and Winmill, 1912.)

| t° | Gm. Equiv. $(CH_3)_3N$ per liter of aq. layer | Dist. Coef. |
|---|---|---|
| 18 | 0.0688 | 3.297 |
| " | 0.0791 | 3.290 |
| 25 | 0.0677 | 2.291 |
| " | 0.0641 | 2.297 |
| 37.35 | 0.1182 | 1.815 |
| " | 0.1248 | 1.820 |

Similar data for the distribution of tri methyl amine between water and Toluene at 25° and at other temperatures are given by Hantzsch and Sebalt, 1899, and Hantzsch and Vagt, 1901.

## TRI METHYL AMINE

### Distribution of Tri Methyl Amine at 25° Between:

(Herz and Stanner, 1927.)

#### Water and Benzene

| Gm. Mols. $(CH_3)_3N$ per liter | | 2/1 |
|---|---|---|
| $H_2O$ layer(1) | $C_6H_6$ layer(2) | |
| 0.1485 | 0.0701 | 0.472 |
| 0.2722 | 0.1278 | 0.470 |
| 0.5299 | 0.2474 | 0.467 |
| 0.6392 | 0.3052 | 0.477 |
| 0.7876 | 0.3773 | 0.477 |

#### Water and Toluene

| Gm. Mols. $(CH_3)_3N$ per liter | | 2/1 |
|---|---|---|
| $H_2O$ layer(1) | $C_6H_5CH_3$ layer(2) | |
| 0.0767 | 0.0367 | 0.478 |
| 0.1775 | 0.0775 | 0.437 |
| 0.2652 | 0.1163 | 0.438 |
| 0.3570 | 0.1530 | 0.429 |
| 0.5222 | 0.2223 | 0.426 |
| 0.6385 | 0.2693 | 0.422 |

#### Water and m Xylol

| Gm. Mols. $(CH_3)_3N$ per liter | | 2/1 |
|---|---|---|
| $H_2O$ layer(1) | m $C_6H_4(CH_3)_2$(2) | |
| 0.1352 | 0.0546 | 0.404 |
| 0.2503 | 0.0909 | 0.363 |
| 0.3667 | 0.1333 | 0.364 |
| 0.4879 | 0.1727 | 0.354 |

#### Water and Ethyl Benzene

| Gm. Mols. $(CH_3)_3N$ per liter | | 2/1 |
|---|---|---|
| $H_2O$ layer(1) | $C_6H_5C_2H_5$ layer(2) | |
| 0.1478 | 0.0546 | 0.370 |
| 0.2164 | 0.0831 | 0.384 |
| 0.2885 | 0.1049 | 0.364 |
| 0.3672 | 0.1333 | 0.363 |

The authors also give a series of determinations of the distribution of trimethyl amine between aqueous solutions of various salts and benzene at 25°. The results in general show that less amine enters the aqueous layer in presence of the salts, thus corresponding to a salting out effect. Chlorides have the greatest effect, bromides next and iodides least.

## TRI METHYL AMINE CHLOROPLATINATE $(CH_3)_3N.H_2PtCl_6$.

### Solubility of Tri Methyl Amine Chloroplatinate in Aqueous Ethyl Alcohol.

(Bertheaume, 1910.)

| Concentration of Aqueous Alcohol | Gms. $(CH_3)_3NH_2PtCl_6$ per 100 gms. solvent |
|---|---|
| 60° | 0.766 |
| 70° | 0.391 |
| 80° | 0.243 |
| 90° | 0.070 |
| 100° | 0.0036 |

Di **METHYL AMINE** Acid Phthalate.

Tri **METHYL AMINE** Acid Phthalate.

DISTRIBUTION OF EACH SEPARATELY AT 25° BETWEEN ACETONE AND GLYCEROL.
(Smith, 1921, 1922.)

NOTE. — "The acid phthalate salts were made by mixing standardized solutions of phthalic acid, on the one hand, and the desired amine on the other, in the proportion of two to one. It was assumed that the remaining titratable hydrogen of the phthalic acid represents one molecule of the amine acid salt."

Results for Dimethyl Amine Acid Phthalate.

| Millimols. acid Phthalate per liter of | | |
|---|---|---|
| Acetone layer (A). | Glycerol layer (G). | $\frac{A}{G}$. |
| 0.6250 | 3.725 | 0.168 |
| 0.8125 | 5.4875 | 0.148 |
| 1.00 | 7.80 | 0.128 |
| 1.30 | 10.875 | 0.119 |
| 1.70 | 14.75 | 0.115 |

Results for Trimethyl Amine Acid Phthalate.

| Millimols. acid Phthalate per liter of | | |
|---|---|---|
| Acetone layer (A). | Glycerol layer (G). | $\frac{A}{G}$. |
| 0.70 | 4.20 | 0.167 |
| 0.90 | 5.65 | 0.159 |
| 1.50 | 10.35 | 0.145 |
| 1.95 | 13.55 | 0.144 |

**PROPYL AMINE** $C_3H_7.NH_2$.

DISTRIBUTION OF PROPYL AMINE BETWEEN WATER AND XYLENE AT 25°.
(Smith. 1921, 1922.)

| Millimols. $C_3H_7.NH_2$ per liter of | | $\frac{C_2}{C_1}$. |
|---|---|---|
| $H_2O$ layer ($C_1$). | Xylene layer ($C_2$). | |
| 2.45 | 0.60 | 0.245 |
| 4.80 | 1.30 | 0.270 |
| 7.75 | 2.25 | 0.290 |

**SULFONIUM PERCHLORATES**

SOLUBILITY IN WATER.
(Hofmann, Höbold and Quoos, 1911–12.)

| Name. | Formula. | t°. | Per 100 Gms. $H_2O$. | |
|---|---|---|---|---|
| | | | Gm. Mols. | = Gms. |
| Trimethyl Sulfine Perchlorate | $(CH_3)_3SClO_4$ | 16.5 | 0.0784 | 13.84 |
| Ethyl dimethyl " " | $C_2H_5(CH_3)_2SClO_4$ | 15.9 | 0.1191 | 22.31 |
| Propyl " " " | $C_3H_7(CH_3)_2SClO_4$ | 15 | 0.0590 | 12.04 |
| *n* Butyl " " " | $C_4H_9(CH_3)_2SClO_4$ | 15 | 0.0607 | 13.24 |
| Ethylene *dis*methyl " " | $C_2H_4(C_2H_6SClO_4)_2$ | 18 | 0.0423 | 14.86 |
| Vinyl dimethyl " " | $C_2H_3.S(CH_3)_2.ClO_4$ | 18 | 0.0731 | 13.75 |
| Trimethylene *dis*methyl " " | $C_3H_6:(C_2H_6SClO_4)_2$ | 18 | 0.0402 | 14.68 |

**INDOL** (Tetraiodopyrrol) $C_4HI_4NH$.

SOLUBILITY OF INDOL IN SEVERAL SOLVENTS.
(U.S.P. VIII; Vulpius, 1893.)

| Solvent | t° | Gms. $C_4HI_4NH$ per 100 gms. solvent |
|---|---|---|
| Water | 25 | 0.0204 |
| Alcohol | 25 | 11.1 |
| Ethyl Ether | 25 | 66.6 |
| Chloroform | 25 | 0.95 |

**MALEIC ANHYDRIDE** $C_4H_2O_3$.

100 cc. xylene dissolve 16.32 gms. maleic anhydride at 29°.7.
100 cc. coal tar heavy solvent dissolve 9.04 gms. maleic anhydride at 29°.7.
(Weiss and Downs, 1923.)

**MALEIC DIAMIDE** $C_4H_2O_2(NH_2)$.

100 cc. $H_2O$ dissolve 0.248 gm. maleic diamide at 50°. (Viseur, 1926.)

Freezing-point data for mixtures of maleic anhydride and succinic anhydride are given by Grimm, Gunther and Titus, 1931.

ALLOXANE $\underbrace{NHCONHCOCO}_{}CO$.

100 cc $H_2O$ dissolve about 0.08 gm. alloxane
10 cc cold sat. aq. solution of $Mg(ClO_4)_2$ dissolve about 0.3 gm. alloxane. (Duclaux and Durand-Gasselin, 1938.)

DICYANO ETHANE $C_2H_4(CN)_2$.

Freezing-point data for mixtures 1.1.2.2 dicyano ethane and each of the following compounds are given by Timmermans and Mme. Vesselovsky, 1931: Carbon tetrachloride, ethane tetra ethyl carboxylate, ethane tetra methyl carboxylate, ethyl succinate, methyl succinate 1.2 dichloro ethane and tetra chloroethane.

**SUCCINIC NITRILE** (Ethylene Cyanide) $CNCH_2CH_2CN$.

The solubility of succinic nitrile in water and also in aqueous sodium chloride solutions at various temperatures has been determined by Schreinemakers (1897), and the results presented in terms of mols. of nitrile per 100 mols. of nitrile + $H_2O$. The following calculations of these results to gram quantities was made by Rothmund. (Landolt and Börnstein's, "Tabellen" 1906.)

| t°. | Gms. $CNCH_2CH_2CN$ per 100 Gms. | | t°. | Gms. $CNCH_2CH_2CN$ per 100 Gms. | |
|---|---|---|---|---|---|
| | Aq. Layer. | Nitrile Layer. | | Aq. Layer. | Nitrile Layer. |
| 18.5 | 10.2 | 92 | 53.5 | 33.2 | 66.4 |
| 20 | 11 | 91.5 | 55 | 40.3 | 62.8 |
| 39 | ... | 85.2 | 55.4 crit. temp. | 51 | |
| 45 | 22 | ... | | | |

Very complete data for the system succinic acid nitrile, ethyl alcohol and water, determined by the synthetic sealed-tube method, are given by Schreinemakers (1898c). Results for the system succinic acid nitrile, cane sugar and water are given by Timmermans (1907).

Data for the system ethyl ether, succinic acid nitrile and water are given by Schreinemakers, 1898.

DISTRIBUTION OF ETHYLENE CYANIDE BETWEEN WATER AND CHLOROFORM.
(Hantzsch and Vagt, 1901.)

| t°. | Gm. Mols. $C_2H_4(CN)_2$ per Liter. | | Ratio, $\frac{c_1}{c_2}$. |
|---|---|---|---|
| | Aq. Layer, $c_1$. | $CHCl_3$ Layer, $c_2$. | |
| 0 | 0.0786 | 0.0464 | 1.69 |
| 10 | 0.0787 | 0.0463 | 1.70 |
| 20 | 0.0791 | 0.0459 | 1.72 |

Additional data for the influence of KOH, KCl and HCl on the above distribution are also given.

**BARBITURIC ACID** $\underline{NHCONHCOCH_2}CO$.

Freezing-point data are given by Hammick and Hanson, 1933, for mixtures of barbituric acid and antipyrine and for barbituric acid and sarcosine anhydride.

**SUCCINCHLORIMIDE** $[CH_2CO]_2NCl$.

SOLUBILITY OF SUCCINCHLORIMIDE IN SEVERAL SOLVENTS AT 20°.
((Wood, 1930.)

The recrystallized sample of m. pt. 146-7° was stirred 30 minutes with each solvent, the solution filtered and titrated with 0.1 n sodium thiosulfate.

| Solvent | Gms. $C_4H_4ClO_2N$ per 100 gms. sat. sol. | Solvent | Gms. $C_4H_4ClO_2N$ per 100 gms. sat. sol. |
|---|---|---|---|
| Carbon Tetrachloride | 0.09 | Water | 1.25 |
| Eucalyptol | 0.16 | Benzene | 1.70 |
| n Amyl alcohol | 0.22 | Methanol | 1.73 |
| Glycerol | 0.33 | Chloroform | 3.77 |
| Xylol | 0.76 | Glacial acetic acid | 4.81 |
| Ethanol (95%) | 0.98 | s Dichloro ethane | 5.41 |
| Toluene | 1.10 | s Tetra chloro ethane | 6.63 |
| | | Acetone | 9.71 |

**THIOPHENE** $C_4H_4S$.

Freezing-point data for mixtures of thiophene and benzene are given by Tsakalotos and Guye, 1910

**FUMARIC ACID** COOH.CH:CHCOOH.
**MALEIC ACID** COOH.CH:CHCOOH.

SOLUBILITY OF EACH SEPARATELY IN WATER.
(Lange and Sinks, 1930.)

Determinations were made at approximately 5° intervals between 0° and 80° and curves plotted from the results. The following equations for the grams of acid per 100 grams sat. solution were calculated from the curves. Fumaric Acid, $C = 0.01672t - 0.6362$ and Maleic Acid at 0° to 40° $C = 0.645\ t + 28.2$ and from 40° to 80° $C = 0.492\ t + 34.5$. Using the above equations the following values have been calculated.

| t° | Gms. per 100 gms. sat. sol. Fumaric acid | Maleic acid | t° | Gms. per 100 gms. sat. sol. Fumaric acid | Maleic acid |
|---|---|---|---|---|---|
| 0 | 0.231 | 28.2 | 40 | 1.077 | 54.1 |
| 10 | 0.330 | 34.6 | 50 | 1.584 | 59.1 |
| 20 | 0.499 | 41.1 | 60 | 2.328 | 64.0 |
| 25 | 0.605(0.706) | 44.3(52.09) | 70 | 3.422 | 68.9 |
| 30 | 0.734 | 47.5 | 80 | 5.028 | 73.9 |

The authors also give results for the densities and refractive indices of aqueous solutions of these acids.

The results in parentheses in the above table are by Reyer, 1923, and are in terms of gms. per 100 cc of saturated solution.

### Solubility of Fumaric and of Maleic Acid Each Determined Separately, in Several Solvents.

(Weiss and Downs, 1923.)

| Solvent. | t°. | Gms. per 100 gms. solvent: Fumaric acid. | Maleic acid. | |
|---|---|---|---|---|
| Water | 25 | 0.70 | 78.8 | |
| » | 40 | 1.07 | 112.5 | |
| » | 60 | 2.4 | 148.7 | |
| » | 100 | 9.8 | 392.6 | (97°.5) |
| 95 % Ethyl alcohol | 29.7 | 5.75 | 69.9 | |
| Ethyl Ether | 25 | 0.72 | 8.19 | |
| Chloroform | 25 | 0.02 | 0.011 | |
| Carbon Tetrachloride | 25 | 0.027 | 0.002 | |
| Benzene | 25 | 0.003 | 0.024 | |
| Acetone | 29.7 | 1.72 | 35.77 | |
| Xylene | 29.7 | 0.027 | 0.0085 | |
| Coal tar (heavy solvent) | 29.7 | 0.0343 | 0.0085 | |
| Acetone | 20 | 1.29 | 25.01 | (Viseur, 1926.) |
| Acetylene dichloride (trans) (b. pt. 48°.3). | 40 | 0.002 | 0.076 | (Lebrun, 1925) |
| » « (cis) ( » 60°.2). | 40 | 0.002 | 0.049 | » |
| Crotonic Nitrile (b. pt. 107°.7–108°.2) | 50 | 0.076 | (30°) 5.80 | » |
| » » ( » 121°.8–122°.2) | 50 | 0.034 | 4.58 | » |

Data for the solubility of fumaric acid in acetone solutions of maleic acid at 20° and vice versa, and for the solubility of fumaric and maleic acids in acetone solutions of succinic acid at 20° and vice versa are given by Viseur, 1926.

(1) These results by Viseur are in terms of gms. per 100 cc of acetone.

### Distribution of Maleic Acid at 25° Between : (Smith, 1921, 1922.)

Water and Ethyl Ether.

| Millimols. COOH.CH:CH.COOH per liter of: $H_2O$ layer ($C_1$). | $(C_2H_5)_2O$ layer ($C_2$). | $\frac{C_2}{C_1}$. |
|---|---|---|
| 1.56 | 0.215 | 0.138 |
| 2.50 | 0.35 | 0.140 |
| 4.85 | 0.75 | 0.153 |
| 7.25 | 1.025 | 0.141 |
| 11.45 | 1.90 | 0.166 |

Acetone and Glycerol.

| Millimols. COOH.CH:CH.COOH per liter of: Acetone layer (A). | Glycerol layer (G). | $\frac{A}{G}$. |
|---|---|---|
| 0.4375 | 1.925 | 0.454 |
| 0.95 | 2.50 | 0.380 |
| 1.75 | 3.285 | 0.454 |
| 3.50 | 7.40 | 0.473 |
| 6.85 | 13.05 | 0.525 |

### Distribution of Fumaric Acid at 25° Between : (Smith, 1921, 1922.)

Water and Ether.

| Millimols. $(CH)_2(COOH)_2$ per liter.: $H_2O$ layer ($C_1$). | $(C_2H_5)_2O$ layer ($C_2$). | $\frac{C_2}{C_1}$. |
|---|---|---|
| 1.01875 | 0.4625 | 0.454 |
| 1.5125 | 0.8375 | 0.554 |
| 2.60 | 1.70 | 0.654 |
| 4.80 | 3.50 | 0.729 |
| 8.85 | 6.75 | 0.763 |

Acetone and Glycerol.

| Millimols. $(CH)_2(COOH)_2$ per liter.: Acetone layer (A). | Glycerol layer (G). | $\frac{A}{G}$. |
|---|---|---|
| 0.730 | 0.6350 | 0.870 |
| 1.3375 | 1.1875 | 0.888 |
| 2.225 | 2.125 | 0.954 |
| 5.275 | 5.175 | 0.981 |

Data for the distribution of maleic acid between ether and water at 25° are given by Chandler, 1908.

### Solubility of Maleic Acid in Several Solvents.

(Timofeiew, 1894.)

| Alcohol. | t°. | Gms. $(CHCOOH)_2$ per 100 Gms. Sat. Sol. | Alcohol. | t°. | Gms. $(CHCOOH)_2$ per 100 Gms. Sat. Sol. |
|---|---|---|---|---|---|
| Methyl Alcohol | 22.5 | 41 | Propyl Alcohol | 0 | 20 |
| Ethyl Alcohol | 0 | 30.2 | " | 22.5 | 24.3 |
| " | 22.5 | 34.4 | Isobutyl Alcohol | 0 | 14.2 |
| | | | " | 22.5 | 17.5 |

### Solubility of Maleic and of Fumaric Acids, Each Separately in Several Stereoisomeric Solvents.

(Lebrun, 1930.)

| Solvent | Results for Maleic Acid: t° | Gms. acid per 100 gms. solvent | Results for Fumaric Acid: t° | Gms. acid per 100 gms. solvent |
|---|---|---|---|---|
| cis Dichloro acetylene | 40 | 0.049 | 40 | < 0.002 |
| Trans " " | 40 | 0.076 | 40 | < 0.002 |
| Crotonic nitrile | 50 | 4.58 | 50 | 0.034 |

Data for the Solubility of Maleic Acid in Acetone in presence of Fumaric Acid and vice versa as well as for the solubility of these two acids in presence of succinic acid and vice versa at 20° are given by Viseur, 1926.

Freezing-point data for mixtures of maleic acid and *i* mandelic acid are given by Centnerszwer, 1899.

Freezing-point data for various binary mixtures composed of fumaric acid, maleic acid, succinic acid, methyl and ethyl fumarates, maleates and succinates, fumaride, succinamide and maleic diamide are given by Viseur, 1926.

Results for mixtures of Maleic and Fumaric Acid Menthyl esters are given by Wassermann, 1932.

Sodium **FUMARATES** $NaH(CHCOO)_2$ and $Na_2(CHCOO)_2$.
Sodium **MALEATES** $NaH(CHCOO)_2$ and $Na_2(CHCOO)_2$.

### Solubility of Each in Aqueous Alcohol.

(McDermott, 1940.)

| Compound | Solvent | t° | Gms. Compound per 100 cc sat. solution |
|---|---|---|---|
| NaH Maleate | Aq. 41.5 Vol. % $C_2H_5OH$ | 23-5 | 2.01 |
| " " | " 95 " " " | " | 0.284 |
| $Na_2$ " | " 73.9 " " " | " | 1.325 |
| NaH Fumarate | " 58.3 " " " | " | 1.41 |
| $Na_2$ " | " 52.0 " " " | " | 1.25 |

## DICHLORO SUCCINIC ACID $C_2H_2Cl_2(COOH)_2$.

### Solubility of Dichloro Succinic Acids in Water and Other Solvents at 25°.

(Holmberg, 1921.)

| Compound. | Solvent. | Gms. cmpd. dissolved per liter of sat. sol. |
|---|---|---|
| *Meso* Dichloro Succinic acid (m. pt. 217-18°) | $CH_3COOH+C_6H_6$* | 3.17 |
| Acid salt of » » » with *i* Phenylethylamine | $H_2O$ | 81.4 |
| » » » » » » » *d* » | » | 76.4 |
| » » » » » » » *l* » | » | 76.1 |
| Racemic » » » (m. pt. 174-5°) | $CH_3COOH+C_6H_6$ | 11.03 |
| Acid salt of » » » with *i* Phenylethylamine | $H_2O$ | 18.67 |
| Dextro » » » (m. pt. 166-7°) | $CH_3COOH+C_6H_6$ | 22.6 |
| Acid salt of » » » with *d* Phenylethylamine | $H_2O$ | 21.8 |
| » » » » » » » *l* » | » | 75.4 |
| Laevo » » » (m. pt. 166-7°) | $CH_3COOH+C_6H_6$ | 22.5 |
| Acid salt of » » » with *d* Phenylethylamine | $H_2O$ | 75.8 |
| » » » » » » » *l* » | » | 21.8 |

* The mixture consisted of 10 volumes of $CH_3COOH$ diluted to 100 volumes with $C_6H_6$.

Freezing-point data for mixtures of d and l Dichloro Succinic Acid and for mixtures of d and of l Dichloro Succinic Acid with Asparigine and with lactamide are given by Timmermans, Van Lancker and Jaffe, 1939.

**ALLYL CYANIDE** $CH_2:CHCH_2CN$.

Freezing-point data for mixtures of allyl cyanide and aniline are given by Lafortune, 1923.

**CROTONIC ACID NITRILE** $CH_3CH:CHCN$.

Freezing-point data for mixtures of Crotonic Acid nitrile and aniline are given by Lafortune, 1923.

**ALLYL iso SULFOCYANIDE** $CH_2:CHCH_2NCS$.

Freezing-point data are given by Joukovsky, 1934, for mixtures of allyl iso sulfocyanide with benzene, with nitrobenzene, and with formic acid. The author also gives results for the total and partial vapor pressures at 20.5° of allyl iso sulfocyanide and ethyl ether, methyl alcohol and carbon disulfide.

Freezing-point data for mixtures of Allyl iso sulfocyanide (Allyl mustard oil) and aniline are given by Kurnakov and Kviot, 1913; and Kurnakov and Solover, 1916.

**SUCCINIMIDE** $\begin{matrix}CH_2CO\\CH_2CO\end{matrix}>NH.H_2O$.

Solubility of Succinimide Hydrate in Water and in Ethyl Alcohol.
(Speyers, 1902)

| In Water. | | | | In Ethyl Alcohol. | | | |
|---|---|---|---|---|---|---|---|
| t°. | Wt. of 1 cc. of sat. sol. | Mols. per 100 mols. sol. | Gms. per 100 gms. $H_2O$. | t°. | Wt. of 1 cc. of sat. sol. | Mols per 100 mols. sol. | Gms. per 100 gms. $C_2H_5OH$. |
| 0... | 1.025 | 1.58 | 10.4 | 0... | 0.815 | 0.88 | 2.26 |
| 10... | 1.035 | 2.4 | 17.5 | 10... | 0.809 | 1.35 | 3.4 |
| 20... | 1.052 | 4.0 | 30.0 | 20... | 0.806 | 2.0 | 5.2 |
| 25... | 1.067 | 5.9 | 44.0 | 25... | 0.805 | 2.5 | 6.6 |
| 30... | 1.086 | 8.0 | 60.0 | 30... | 0.804 | 3.1 | 8.4 |
| 40... | 1.120 | 12.8 | 95.0 | 40... | 0.809 | 4.9 | 13.4 |
| 50... | 1.145 | 17.8 | 135.0 | 50... | 0.816 | 7.8 | 21.0 |
| 60... | 1.167 | 22.6 | 185.0 | 60... | 0.835 | 12.3 | 36.0 |
| 70... | 1.189 | 27.5 | 245.0 | 70... | 0.873 | – | – |

100 cc sat. aq. $Mg(ClO_4)_2$ solution dissolve about 4.0 gms. succinimide at about 10°. (Duclaux and Durand-Gasselin, 1938.)

Freezing-point data are given for mixture of succinimide and:

Hydroquinone (1)
α Naphthol (1)
β " (1)
o Nitro phenol (1)
m " (1)
p " (1)
1.2.4 Dinitro phenol (1)
1.4 Dioxy naphthalene (1)
1.6 " " (1)
2.3 " " (2)
2.6 " " (1)
Pyrocatechol (1)
Picric acid (1)
Pyrogallol (1)
Resorcinol (1)
Succinic anhydride (3)

(1) Kremann and Dietrich, 1923; Kremann, Hemmelmayr, 1922; (3) Grimm, Günther and Titus, 1931.

**BUTYLCHLORALHYDRATE** $CH_3CHCl.CCl_2.CH(OH)_2$.

100 gms. $H_2O$ dissolve 2.7 gms. butylchloralhydrate at 15.5° (Greenish and Smith, 1903.)
" " " 2.3 " " at 15°–20°. (Squire and Caines, 1905.)
" glycerol " 100 " " at 15°–20°. (Greenish and Smith, 1903.)

The partition coefficient of butylchloralhydrate between olive oil and water is given as 1.589 at ord. temp. (Baum, 1899.)

**BUTYLCHLORAL** $CH_3CHCl.CCl_2CHO$.

The distribution coefficient of butylchloral between oil and water is given as 1.6. (Meyer, 1907.)

**TRI CHLORO β HYDROXY BUTYRIC ACIDS** $CCl_3CH(OH)CH_2COOH$.

Freezing-point data for mixtures of the optical isomerides of Tri chloro β Hydroxy Butyric Acid are given by Ross. 1936.

Brom**SUCCINIC ACID** $CHBr(CH_2)(COOH)_2$ (m. pt. 159°).

SOLUBILITY IN ALCOHOLS AT 22°.
(Timofeiew, 1894.)

| Alcohol. | Gms. $CHBr(CH_2)(COOH)_2$ per 100 Gms. | |
|---|---|---|
| | Sat. Solution. | Alcohol. |
| Methyl Alcohol | 56.5 | 129.7 |
| Ethyl Alcohol | 45.5 | 83.6 |
| Propyl Alcohol | 33.1 | 49.4 |

Data for the distribution of monobromsuccinic acid between water and ether at 25° and for dibromsuccinic acid between water and ether at 25° are given by Chandler (1908).

DISTRIBUTION OF BROM SUCCINIC ACID AT 25° BETWEEN : (Smith, 1921, 1922.)

Water and Ether.

| Millimols. $CHBrCH_2(COOH)_2$ per liter | | |
|---|---|---|
| $H_2O$ layer ($C_1$). | $(C_2H_5)_2O$ layer ($C_2$). | $\frac{C_2}{C_1}$. |
| 0.63125 | 0.4500 | 0.712 |
| 1.3625 | 1.1625 | 0.853 |
| 2.00 | 1.925 | 0.963 |
| 3.50 | 3.85 | 1.10 |
| 6.70 | 8.90 | 1.35 |

Water and Glycerol.

| Millimols. $CHBrCH_2(COOH)_2$ per liter | | |
|---|---|---|
| Acetone layer (A). | Glycerol layer (G). | $\frac{A}{G}$. |
| 1.625 | 1.281 | 1.27 |
| 2.375 | 1.725 | 1.34 |
| 5.575 | 3.925 | 1.42 |
| 11.575 | 7.675 | 1.51 |

Water and Xylene.

| Millimols. $CHBrCH_2(COOH)_2$ per liter of | | | |
|---|---|---|---|
| $H_2O$ layer..... | 25.90 | 61.70 |
| Xylene layer..... | 0.555 | 1.85 |

Data for the melting-points of mixtures of the following pairs of optical antipodes are given by Centnerszwer (1899).

*d* + *l* Chlorsuccinic Acid.
*d* + *i* Chlorsuccinic Acid.
*d* Chlorsuccinic Acid + *l* Bromsuccinic Acid.
*i* Chlorsuccinic Acid + *l* Bromsuccinic Acid.
*d* + *l* Benzylaminosuccinic Acid.
*d* + *l* Aminosuccinic Acid.

Freezing-point data for mixtures of d and l bromo and chloro succinic acids are given by Timmermans, 1929.

Chloro **SUCCINIC ACIDS** l and d $CHCl(CH_2)(COOH)_2$.

SOLUBILITY OF CHLOROSUCCINIC ACID IN WATER.
(Timmermans and Heuse, 1931.)

| t° | Gms. $C_4H_5ClO_4$ per 100 gms. $H_2O$ | Solid Phase | t° | Gms. $C_4H_5ClO_4$ per 100 gms. $H_2O$ | Solid Phase |
|---|---|---|---|---|---|
| -0.58 | 4.18 | Ice | -2.32* | 21.46 | Ice |
| -1.10 | 8.62 | " | +10 | 16.98 | $C_4H_5ClO_4$ d |
| -1.38 | 11.0 | " + $C_4H_5ClO_4$ | +20 | 24.44 | " l |
| -1.92 | 16.9* | Ice | | | |

* Unstable.

The authors also give results for the freezing-points of the ternary system ChloroSuccinic Acid + Aspartic Acid + Water.

Freezing-point results for the ternary system Chloro Succinic Acid + Phenyl Glycolic Acid + Water are given by Timmermans and Motiuk, 1932.

100 gms. Ethyl Ether dissolve 13.96 gms. d $C_4H_5ClO_4$ at 20°.
" " " " " 13.90 " l " " "

(Timmermans and Dumont, 1931.)

Freezing-point data are given for mixtures of Chlorosuccinic Acid and: Asparigine by Timmermans and Vesselovsky, 1932, Results for mixtures of Chlorosuccinic Acid and each of the following compounds:

d and l Malic Acids, Tartaric Acids and Meso Tartaric Acids are given by Timmermans and Heuse, 1931.

Results for mixtures of methyl chlorosuccinate + methyl tartrate are given by Timmermans and Vesselovsky, 1932.

## TRI CHLORO BUTYRIC ACID $C_4H_5Cl_3O_2$.

### Distribution of Trichloro Butyric Acid Between Water and Benzene at 18°.

(Drucker, 1904.)

| Gm. Mols. $C_4H_5Cl_3O_2$ per liter | | $\frac{1}{2}$ |
|---|---|---|
| $H_2O$ layer(1) | $C_6H_6$ layer (2) | |
| 0.01710 | 0.002344 | 7.29 |
| 0.03402 | 0.00836 | 4.07 |
| 0.07863 | 0.04211 | 1.865 |
| 0.1468 | 0.1732 | 0.847 |

## β CHLORO CROTONIC ACID $CH_3CCl{:}HCCOOH$.
## β CHLORO ISO CROTONIC ACID $CH_3CCl{:}COOHCH$

### Solubility of β Chloro Crotonic Acid and of β Chloro Iso Crotonic Acid, Each Separately, in Several Stereoisomeric Solvents.

(Lebrun, 1930.)

| Solvent | Results for β Chloro Crotonic Acid | | Results for β Chloro Iso Crotonic Acid | |
|---|---|---|---|---|
| | t° | Gms. acid per 100 gms. solvent | t° | Gms. acid per 100 gms. solvent |
| Cis Dichloro Acetylene | 0 | 5.75 | 0 | 32.20 |
| " " " | 0 | — | 39 | 3.11 |
| Trans " " | 0 | 2.36 | 0 | 37.29 |
| " " " | | — | 39 | 1.64 |
| Cis β Ethyl Chloro iso Crotonate | 20 | 8.93 | 20 | 58.1 |
| Cis 2. Bromo butene | 0 | 1.46 | 0 | 16.96 |
| Trans 2. " " | 0 | 1.15 | 0 | 17.30 |

Freezing-point data for mixtures of β chloro crotonic acid and β chloro iso crotonic acid are given by Skaw and Saxton, 1928, 1933.

Results for mixtures of chloro crotonic acid and dimethyl pyrone are given by Kendall, 1914, and for mixtures of chloro tonic acid and sulfuric acid are given by Kendall and Carpenter, 1914.

**ALLYL MUSTARD OIL** (Iso thiocyanic acid allyl ester) $CH_2:CHCH_2NCS$.

Results for equilibrium in the ternary and quarternary systems composed of Allyl mustard oil, Piperidine, Dimethyl aniline and Water at 20° are given by Oust-Katchkintzev and Mertzline, 1936.

SOLUBILITY OF ALLYL ISOTHIOCYANIC ESTER IN SULFUR BY SYNTHETIC METHOD.
(Alexejew, 1886.)

| t°. | Gms. Mustard Oil per 100 Gms. | |
|---|---|---|
| | Sulfur Layer. | Mustard Oil Layer. |
| 90 | 10 | 72 |
| 100 | 12 | 67 |
| 110 | 15 | 62 |
| 120 | 23 | 51 |
| 124 (crit. temp.) | 35 | |

Freezing-point data for allyl isothiocyanate + aniline are given by Kurnakov and Solovev (1916). Results for methyl isothiocyanate + phenanthrene and methyl isothiocyanate + naphthalene are given by Kurnakov and Efrenov (1912).

Freezing-point data are given for the system Allyl mustard oil, Nitrobenzene and p Dibrom benzene by Schischokin, 1930.

**FUMARAMIDE** $CONH_2.CH:CH.CONH_2$.

100 cc. $H_2O$ dissolve 0.146 gm. fumaramide at 50°. (Viseur, 1926.)

**CROTONIC ACID** α $CH_3CH:CHCOOH$ (solid).
**ISO CROTONIC ACID** β $CH_3CH:COOHCH$ (liquid).

SOLUBILITY OF CROTONIC ACID AND OF ISO CROTONIC ACID, EACH SEPARATELY, IN SEVERAL STEREOISOMERIC SOLVENTS.
(Lebrun, 1925; 1930.)

| Solvent | t° | Gms. Crotonic Acid per 100 gms. solvent | t° | Gms. Iso Crotonic Acid per 100 gms. solvent |
|---|---|---|---|---|
| Cis acetylene dichloride | 0 | 20.83 | 0 | 100+ |
| Trans " " | 0 | 17.12 | 0 | 100+ |
| Cis Bromobutene | 40 | 8.62 | 40 | 100+ |
| Trans " | 0 | 7.88 | 0 | 100+ |

DISTRIBUTION OF α CROTONIC ACID AT 25° BETWEEN : (Smith, 1921-1922.)

Water and Chloroform.

| Millimols. per liter | | |
|---|---|---|
| $H_2O$ layer ($C_1$). | $CHCl_3$ layer ($C_2$). | $\frac{C_2}{C_1}$. |
| 2.35 | 0.75 | 0.319 |
| 3.55 | 1.30 | 0.366 |
| 5.10 | 2.125 | 0.417 |
| 7.15 | 3.40 | 0.475 |

Water and Ether.

| Millimols. per liter | | |
|---|---|---|
| $H_2O$ layer ($C_1$). | $(C_2H_5)_2O$ layer ($C_2$). | $\frac{C_2}{C_1}$. |
| 0.54 | 1.70 | 3.15 |
| 0.85 | 2.73 | 3.21 |
| 1.24 | 3.92 | 3.16 |
| 1.68 | 5.48 | 3.26 |
| 3.52 | 11.6 | 3.30 |

Water and Xylene.

| Millimols. per liter | | |
|---|---|---|
| $H_2O$ layer ($C_1$). | $C_6H(CH_3)_2$ layer ($C_2$). | $\frac{C_2}{C_1}$. |
| 4.75 | 0.55 | 0.115 |
| 6.3 | 0.80 | 0.127 |
| 13.9 | 2.50 | 0.180 |

## CROTONIC ACID $CH_3CH:CHCOOH$.

### Distribution of Crotonic Acid at 25° Between:

(Smith and Wente, 1929.)

| Water and Chloroform | | Water and Benzene | | Water and Toluene | |
|---|---|---|---|---|---|
| Gm. Mols. $C_4H_6O_2$ per liter | | Gm. Mols. $C_4H_6O_2$ per liter | | Gm. Mols. $C_4H_6O_2$ per liter | |
| $H_2O$ layer | $CHCl_3$ layer | $H_2O$ layer | $C_6H_6$ layer | $H_2O$ layer | $C_6H_5CH_3$ layer |
| 0.00902 | 0.00466 | 0.00969 | 0.00183 | 0.0195 | 0.00422 |
| 0.01239 | 0.00743 | 0.01874 | 0.00485 | 0.0323 | 0.00977 |
| 0.01725 | 0.01258 | 0.03100 | 0.01105 | 0.0474 | 0.01922 |
| 0.02308 | 0.02068 | 0.06215 | 0.03745 | 0.0652 | 0.03440 |
| 0.02793 | 0.02794 | 0.0937 | 0.0804 | 0.0955 | 0.07460 |
| 0.03432 | 0.04015 | 0.1182 | 0.1256 | 0.1261 | 0.11770 |

Freezing-point data are given for mixtures of:

α Crotonic acid + β Crotonic acid (Morell and Hanson, 1904.)
" " + Dimethyl pyrone (Kendall, 1914.)
" " + Sulfuric acid (Kendall and Carpenter, 1914.)
" " + Chlor acetic acids (Kendall, 1914.)

## ACETIC ANHYDRIDE $(CH_3CO)_2O$

### Reciprocal Solubility of Acetic Anhydride and Each of Three Other Liquids.

(Jones and Betts, 1928.)

The determinations were made by the synthetic, sealed tube, method.

Results for Acetic Anhydride + :

| Carbon Disulfide | | Cyclohexane | | Petroleum (b.pt. 170-80°) | |
|---|---|---|---|---|---|
| t° | Gms. $(CH_3CO)_2O$ per 100 gms. homogeneous mixture | t° | Gms. $(CH_3CO)_2O$ per 100 gms. homogeneous mixture | t° | Gms. $(CH_3CO)_2O$ per 100 gms. homogeneous mixture |
| 0.7 | 5.27 | 2.269 tr.pt. | — | 27.6 | 7.14 |
| 16.5 | 9.66 | 20.4 | 7.20 | 38.5 | 9.46 |
| 26.7 | 18.27 | 33.5 | 10.40 | 63.5 | 14.95 |
| 27.2 | 19.18 | 36.2 | 12.09 | 76.1 | 22.59 |
| 29.7 | 32.10 | 43.1 | 16.90 | 80.0 | 26.90 |
| 29.83 | 35.36 | 48.3 | 24.32 | 82.0 | 30.83 |
| 29.83 C.S.T. | 36.17 | 50.3 | 27.97 | 83.5 | 35.00 |
| 29.85 | 36.39 | 52.25 | 39.03 | 85.1 | 42.67 |
| 29.80 | 36.93 | 52.40 | 43.01 | 85.50 C.S.T. | 52.11 |
| 29.80 | 38.01 | 52.42 | 45.35 | 85.52 | 53.50 |
| 29.65 | 41.10 | 52.45 C.S.T. | 47.33 | 85.25 | 60.67 |
| 29.65 | 42.85 | 52.37 | 52.25 | 84.0 | 67.87 |
| 29.5 | 44.2 | 52.00 | 58.83 | 82.55 | 72.08 |
| 28.3 | 52.04 | 51.40 | 62.77 | 80.27 | 76.73 |
| 27.9 | 53.22 | 48.30 | 70.16 | 77.35 | 79.85 |
| 25.7 | 58.57 | 43.50 | 76.03 | 71.00 | 84.91 |
| 19.1 | 67.60 | 29.00 | 84.71 | 40.0 | 94.10 |
| 13.45 | 72.18 | 11.00 | 89.83 | 16.5 | 96.8 |
| 4.0 | 77.98 | | | | |

Results are also given showing the effect of various amounts of acetic acid upon the above critical solution temperatures.

## ACETIC ANHYDRIDE

Freezing-point data are given for mixtures of Acetic Anhydride and:

| | |
|---|---|
| Acetamide (1)(3) | o Nitro benzaldehyde (5) |
| Acetic acid (2)(6) | m " " (5) |
| Benzamide (1)(3) | p " " (5) |
| Benzaldehyde (5) | Piperonal (4) |
| | Piperonylidene di acetate (4) |

(1) Baily, 1925; (2) Pickering, 1893; (3) Kremann, Mauermann and Ostwald, 1922; (4) Jorissen and Van der Beek, 1928; (5) Van der Beek, 1928; (6) Astuki and Ishii, 1931.

## ALLANTOIN $C_4H_6N_4O_3$.

### Solubility in Water.

(Titherly, 1912.)

The author obtained results varying from 0.7 to 0.77 gms. allantoin per 100 gms. $H_2O$ at 25°. The variations were considered to be due to slow decomposition of the compound.

10 cc $H_2O$ dissolve about 0.04 gm. allantoin
10 cc cold sat. aqueous $Mg(ClO_4)_2$ solution dissolve about 0.8 gm. allantoin. (Duclaux and Durand-Gasselin, 1938.)

## DIMETHYL OXALATE $(COOCH_3)_2$.

### Solubility of Dimethyl Oxalate in Water.

(Kendall and Harrison, 1928.)

The determinations were made by the synthetic, sealed tube, method.

| t° | Mol. percent $(COOCH_3)_2$ in sat. sol. | Solid Phase | t° | Mol. percent $(COOCH_3)_2$ in sat. sol. | Solid Phase |
|---|---|---|---|---|---|
| 0.1 | 0.541 | $(COOCH_3)_2$ (solid) | 49.2 | 6.07 | $(COOCH_3)_2$ (solid) |
| 11.1 | 1.242 | " | 51.0 | 6.46 | " |
| 19.5 | 1.853 | " | 53.0 | 6.91 | " |
| 27.1 | 2.68 | " | 75.0 | 8.61 | $(COOCH_3)_2$ (liquid) |
| 31.9 | 3.36 | " | 79.3 | 8.89 | " |
| 44.4 | 5.36 | " | 96.1 | 10.2 | " |

The authors also give the following results for the freezing-points of mixtures of dimethyl oxalate and water.

| t° | Mol. percent $(COOCH_3)_2$ in mixture | t° | Mol. percent $(COOCH_3)_2$ in mixture | t° | Mol. percent $(COOCH_3)_2$ in mixture |
|---|---|---|---|---|---|
| -0.028 | 0.024 | -0.240 | 0.205 | -0.432 | 0.362 |
| -0.073 | 0.060 | -0.330 | 0.280 | -0.490 | 0.414 |
| -0.095 | 0.081 | -0.351 | 0.295 | -0.592 | 0.508 |
| -0.131 | 0.113 | -0.382 | 0.323 | | |

## Di METHYL OXALATE $C_2O_4(CH_3)_2$.

FREEZING-POINTS OF MIXTURES OF DIMETHYL OXALATE AND WATER.

(Skrabal, 1917.)

| t° of f. pt. | Gms. $C_2O_4(CH_3)_2$ per 100 gms. sat. sol. | t° of f. pt. | Gms. $C_2O_4(CH_3)_2$ per 100 gms. sat. sol. | t° of f. pt | Gms. $C_2O_4(CH_3)_2$ per 100 gms. sat. sol. |
|---|---|---|---|---|---|
| − 0.5(Eatec.).. | 4.0 | 36.0..... | 10.7 | 48.0..... | 19.2 |
| + 1.5..... | 4.1 | 38.0..... | 12.5 | 48.2..... | 29.8 |
| 9 5..... | 5.0 | 41.5..... | 13·0 | 48.0..... | 64.4 |
| 21.5..... | 6.6 | 44.5..... | 15.8 | 48.0..... | 93.3* |
| 37.0..... | 9.1 | 48.0..... | 17.7* | 50.5..... | 97·7 |
| | | | | 53.5 m. pt... | 100.0 |

* Between 17.7 and 93.3 Wt. % $C_2O_4(CH_3)_2$ two liquid phases exist.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 100 gms. | $H_2O$ | dissolve | 6.18 gms. | $(CH_3)_2C_2O_4$ | at 20–25°. | (Dehn, 1917.) |
| " | pyridine | " | 4.8 | " | " | " | " |
| " | aq. 50% pyridine | " | 93.1 | " | " | " | " |
| " | 95 % formic acid | " | 22.58 | " | " | at 20.2° | (Aschan, 1913.) |

The critical solution temperature of a mixture of di methyl oxalate and camphene is 62.6° and there is 42.0 percent of dimethyl oxalate present. (Lecat, 1930.)

Results for mixtures of dimethyl oxalate and acetic acid and for mixtures of dimethyl oxalate and chloro acetic acids are given by Kendall and Booge, 1936.

Freezing-point lowering data for mixtures of dimethyl oxalate and the following compounds are given by Kremann, Zechner and Drâzel, 1924 : Hydroquinol, α and β naphthol, phenol, *o*, *m* and *p* nitrophenol, 1.2.4 dinitrophenol, picric acid, pyrocatechol, pyrogallol, resorcinol, *p* toluidine.

## SUCCINIC ACID $(CH_2)_2(COOH)_2$.

SOLUBILITY IN WATER.

(Miczynski, 1886; van der Stadt, 1902; Lamouroux, 1899; for other concordant results, see Bourgoin, 1874; Henry, 1884.)

| t°. | Gms. $(CH_2)_2(COOH)_2$ per 100 | | Gms. Succinic Anhydride $(CH_2)_2COCOO$ per 100 Gms. $H_2O$. | Mol. Per cent. | |
|---|---|---|---|---|---|
| | Gms. $H_2O$. | cc. Solution. | | $H_2O$. | $(CH_2)_2COCOO$. |
| 0 | 2.80 | 2.78 (L.) | 2.34 | 99.58 | 0.42 |
| 10 | 4.51 | 4 | 3.80 | 99.32 | 0.68 |
| 20 | 6.89 | 5.8 | 5.77 | 98.97 | 1.03 |
| 25 | 8.06 | 7 | 6.74 | 98.80 | 1.20 |
| 30 | 10.58 | 8.5 | 8.79 | 98.44 | 1.56 |
| 40 | 16.21 | 12.5 | 13.42 | 97.64 | 2.36 |
| 50 | 24.42 | 18 | 19.95 | 96.53 | 3.47 |
| 60 | 35.83 | 24.5 | 28.77 | 95.07 | 4.93 |
| 70 | 51.07 | ... | 40.11 | 93.26 | 6.74 |
| 80 | 70.79 | ... | 54.08 | 91.12 | 8.88 |
| 89.4 | 95.45 | ... | 70.62 | 88.71 | 11.29 |
| 104.8 | 146.3 | ... | 101.2 | 84.57 | 15.43 |
| 115.1 | 188.5 | ... | 126.8 | 81.4 | 18.6 |
| 134.2 | 335.4 | ... | 187.8 | 74.72 | 25.28 |
| 159.5 | 748.2 | ... | 295.2 | 65.27 | 34.73 |
| 180.6 | 1839 | ... | 408.5 | 57.6 | 42.4 |
| 182.8 | ∞ | ... | 542.3 | 50 | 50 |
| 174.4 | ... | ... | 808.5 | 40.7 | 59.3 |
| 153.3 | ... | ... | 2239 | 19.86 | 80.14 |
| 128 | ... | ... | 8865. | 5.89 | 94.11 |
| 118.8–119 | ... | ... | ∞ | 0 | 100 |

The following very careful determinations of the solubility of succinic acid in water are given by Marshall and Bain (1910).

| t°. | 0°. | 12.5°. | 25°. | 37.5°. | 50°. | 62.5°. | 75°. |
|---|---|---|---|---|---|---|---|
| Gms. $(CH_2)_2(COOH)_2$ per 100 gms. $H_2O$ | 2.75 | 4.92 | 8.35 | 14 | 23.83 | 39.35 | 60.37 |

100 gms. $H_2O$ dissolve 6.75 gms. $(CH_2)_2COOH)_2$ at 20° and 10.5 gms. at 30°. (Wright, 1927.)

A saturated solution of succinic acid in water contains 0.01460 mol. fraction of $(CH_2)_2(COOH)_2$ at 28°. (Desai and Patel, 1935.)

## SUCCINIC ACID $(CH_2)_2(COOH)_2$.

### Solubility of Succinic Acid in Water and in Ethyl Ether.

(Forbes and Coolidge, 1919.)

| Solvent. | t°. | $d\frac{t°}{4}$ of sat. sol. | Gms. $(CH_2)_2(COOH)_2$ per 100 gms. sat. sol. |
|---|---|---|---|
| Water..... | 15 | 1.012 | 5.09 |
| | 20 | 1.016 | 6.30 |
| | 25 | 1.021 | 7.67 |
| Water sat. with ether..... | 15 | 0.999 | 5.68 |
| | 20 | 1.005 | 7.10 |
| | 25 | 1.010 | 8.76 |

| Solvent. | t°. | $d\frac{t°}{4}$ of sat. sol. | Gms. $(CH_2)_2(COOH)$ per 100 gms. sat. sol. |
|---|---|---|---|
| Ether..... | 15 | 0.719 | 0.353 |
| | 20 | 0.714 | 0.420 |
| | 25 | 0.710 | 0.487 |
| Ether sat. with water..... | 15 | 0.730 | 1.289 |
| | 20 | 0.726 | 1.475 |
| | 25 | 0.722 | 1.689 |

### Solubility of Succinic Acid in Aqueous Solutions of Acetic Acid and of Formic Acid at 25°. (Knox and Richards, 1919.)

In Aq. $CH_3COOH$.

| Equiv. Normality | | Equiv. Normality | |
|---|---|---|---|
| $CH_3COOH$. | $(CH_2)_2(COOH)_2$. | $CH_3COOH$. | $(CH_2)_2(COOH)_2$. |
| 0.000 | 1.352 | 6.655 | 1.639 |
| 0.078 | 1.384 | 8.661 | 1.519 |
| 0.448 | 1.415 | 10.340 | 1.357 |
| 0.916 | 1.452 | 12.400 | 1.097 |
| 2.828 | 1.592 | 14.640 | 0.797 |
| 4.536 | 1.643 | 16.850 | 0.514 |

In Aq. HCOOH.

| Equiv. Normality | | Equiv. Normality | |
|---|---|---|---|
| HCOOH. | $(CH_2)_2(COOH)_2$. | HCOOH. | $(CH_2)_2(COOH)_2$. |
| 0.090 | 1.369 | 11.29 | 1.228 |
| 0.446 | 1.397 | 15.29 | 0.944 |
| 0.930 | 1.408 | 17.67 | 0.796 |
| 3.730 | 1.501 | 19.16 | 0.715 |
| 5.547 | 1.531 | 20.53 | 0.667 |
| 7.500 | 1.449 | 22.93 | 0.604 |

### Solubility of Succinic Acid in Aqueous Solutions of Hydrochloric Acid, Nitric Acid and of Sulfuric Acid at 25°. (Knox and Richards, 1919.)

In Aq. Hydrochloric Acid.

| Equiv. Normality | |
|---|---|
| HCl. | $(CH_2)_2(COOH)_2$. |
| 0.00 | 1.352 |
| 2.751 | 0.681 |
| 5.964 | 0.402 |
| 7.335 | 0.353 |
| 8.950 | 0.333 |
| 9.732 | 0.328 |
| 10.400 | 0.337 |
| 11.980 | 0.378 |

In Aq. Nitric Acid.

| Equiv. Normality | |
|---|---|
| $HNO_3$. | $(CH_2)_2(COOH)_2$. |
| 1.299 | 1.134 |
| 3.034 | 0.941 |
| 5.236 | 0.724 |
| 6.616 | 0.652 |
| 9.710 | 0.528 |
| 11.110 | 0.518 |
| 13.510 | 0.561 |
| 15.430 | 0.731 |

In Aq. Sulfuric Acid.

| Equiv. Normality | |
|---|---|
| $H_2SO_4$. | $(CH_2)_2(COOH)_2$. |
| 1.981 | 0.908 |
| 3.816 | 0.683 |
| 4.926 | 0.563 |
| 8.122 | 0.388 |
| 10.220 | 0.340 |
| 13.81 | 0.30 |
| 17.05 | 0.30 |
| 20.28 | 0.39 |
| 23.18 | 0.69 |

## Solubility of Succinic Acid in Aqueous Solutions of Salts at Several Temperatures. (Linderstrom-Lang, 1924.)

| Composition of Aq. Solvent. | | Gm. mols. $(CH_2)_2(COOH)_2$ dissolved per liter at | | |
|---|---|---|---|---|
| Salt used. | Gm. equiv. per liter. | 11°.85. | 18°.0. | 23°.75. |
| None.... | $=H_2O$ | 0.3854 | 0.4974 | 0.6344 |
| Li Cl ... | 0.335 | – | 0.4417 | – |
| » ... | 0.669 | 0.3062 | 0.3950 | 0.5037 |
| » ... | 1.338 | 0.2435 | 0.3151 | 0.4046 |
| » ... | 2.676 | 0.1558 | 0.2018 | 0.2590 |
| » ... | 4.013 | 0.1036 | 0.1348 | 0.1739 |
| Na Cl. | 0.1 | – | 0.4889 | – |
| » ... | 0.4 | 0.3584 | 0.4611 | 0.5853 |
| » ... | 0.8 | 0.3330 | 0.4262 | 0.5406 |
| » ... | 1.6 | 0.2853 | 0.3602 | 0.4597 |
| » ... | 2.4 | – | 0.3091 | – |
| » ... | 3.2 | 0.2082 | 0.2625 | 0.3305 |
| » ... | 4.0 | – | 0.2246 | – |
| K Cl.... | 0.35 | – | 0.4913 | – |
| » .... | 0.70 | 0.3824 | 0.4851 | 0.6112 |
| » .... | 1.4 | 0.3771 | 0.4713 | 0.5909 |
| » .... | 2.1 | 0.3693 | 0.4564 | 0.5708 |
| » .... | 2.8 | 0.3593 | 0.4413 | 0.5459 |
| » .... | 3.5 | – | 0.4262 | – |

| Composition of Aq. Solvent. | | Gm. mols. $(CH_2)_2(COOH)_2$ dissolved per liter at 17°.85. |
|---|---|---|
| Salt used. | Gm. equiv. per liter. | |
| None.... | $=H_2O$ | 0.4920 |
| Rb Cl... | 0.6 | 0.4955 |
| » ... | 1.2 | 0.4980 |
| » ... | 2.4 | 0.4955 |
| Cs Cl ... | 0.578 | 0.5085 |
| » ... | 0.867 | 0.5169 |
| » ... | 1.733 | 0.5355 |
| K Br.... | 0.6 | 0.4938 |
| » .... | 1.2 | 0.4899 |
| » .... | 2.4 | 0.4777 |
| Na I .... | 0.6 | 0.4715 |
| » .... | 1.2 | 0.4502 |
| » .... | 2.4 | 0.4101 |
| KI..... | 0.6 | 0.5132 |
| » ..... | 1.2 | 0.5300 |
| » ..... | 2.4 | 0.5495 |

## Solubility of Succinic Acid in Aqueous Solutions of Salts and of Acids at 25°.

(Herz, 1910b, 1911.)

### In Aq. HBr.

| Gms. per Liter. | |
|---|---|
| HBr. | $C_4H_6O_4$. |
| 0 | 81.21 |
| 79.3 | 57.38 |
| 274.4 | 32.83 |

### In Aq. HCl.

| Gms. per Liter. | |
|---|---|
| HCl. | $C_4H_6O_4$. |
| 18.45 | 66.25 |
| 45.6 | 50.78 |
| 87.9 | 35.42 |
| 166.6 | 27.75 |

### In Aq. KBr.

| Gms. per Liter. | |
|---|---|
| KBr. | $C_4H_6O_4$. |
| 0 | 81.21 |
| 65.45 | 75.58 |
| 260.5 | 69.68 |
| 502.1 | 62.59 |

### In Aq. KCl.

| Gms. per Liter. | |
|---|---|
| KCl. | $C_4H_6O_4$. |
| 28.34 | 75.58 |
| 77.56 | 74.39 |
| 150.7 | 69.68 |
| 267 | 61.41 |

### In Aq. KI.

| Gms. per Liter. | |
|---|---|
| KI. | $C_4H_6O_4$. |
| 0 | 81.21 |
| 46.48 | 79.12 |
| 102.9 | 77.93 |

### In Aq. LiCl.

| Gms. per Liter. | |
|---|---|
| LiCl. | $C_4H_6O_4$. |
| 0 | 81.21 |
| 7.63 | 70.86 |
| 23.32 | 62.59 |
| 57.66 | 47.24 |
| 117 | 29.51 |
| 176.4 | 20.07 |
| 231.5 | 14.17 |

### In Aq. NaCl.

| Gms. per Liter. | | Solid Phase. |
|---|---|---|
| NaCl. | $C_4H_6O_4$. | |
| 18.7 | 74.39 | $C_4H_6O_4$ |
| 32.73 | 69.68 | " |
| 64.3 | 61.41 | " |
| 132.1 | 49.55 | " |
| 289.4 | 27.16 | " |
| 315.1 | 22.44 | NaCl |
| 318 | 4.72 | " |

## Solubility of Succinic Acid in Aqueous Solutions of Phosphorus Acid at 25°

(Redfield and King, 1936.)

| Normality of aq. $H_3PO_3$ | Normality of dissolved $C_4H_6O_4$ | Normality of aq. $H_3PO_3$ | Normality of dissolved $C_4H_6O_4$ |
|---|---|---|---|
| 0.0 | 1.347 | 25.55 | 0.75 |
| 9.79 | 0.90 | 34.20 | 1.34 |
| 16.61 | 0.69 | 35.97 | 1.51 |
| 18.60 | 0.71 | | |

## Solubility of Succinic Acid in Aqueous Solutions of Phosphoric Acid at 25°.

(Walton and Kepfer, 1930.)

| Normality of aq. $H_3PO_4$ | Normality of dissolved $C_4H_6O_4$ | Normality of aq. $H_3PO_4$ | Normality of dissolved $C_4H_6O_4$ |
|---|---|---|---|
| 0.0 | 1.347 | 31.05 | 0.28 |
| 7.38 | 0.78 | 37.79 | 0.38 |
| 14.31 | 0.48 | 38.64 | 0.28 |
| 19.69 | 0.50 | 40.95 | 0.36 |
| 25.38 | 0.30 | 43.96 | 0.49 |

## Solubility of Succinic Acid in Aqueous Solutions of Potassium Succinate and Vice Versa at Several Temperatures.

(Marshall and Cameron. 1907.)

| t°. | Gms. per 100 Gms. Sat. Sol. $H_2C_4H_4O_4$. | Gms. per 100 Gms. Sat. Sol. $K_2C_4H_4O_4$. | Solid Phase. |
|---|---|---|---|
| 0 | 2.71 | 0 | $H_2C_4H_4O_4$ |
| 0 | 7.26 | 8.09 | " $+KH_3(C_4H_4O_4)_2$ |
| 0 | 7.86 | 7.66 | " " |
| 0 | 8.24 | 9.95 | $KH_3(C_4H_4O_4)_2$ |
| 0 | 8.11 | 12.77 | " |
| 0 | 7.87 | 15.47 | " $+KHC_4H_4O_4.2H_2O$ |
| 0 | 0 | 40.2 | $K_2C_4H_4O_4.3H_2O$ |
| 14 | 1.468 | 41.3 | $K_2C_4H_4O_4+KHC_4H_4O_4$ $+KHC_4H_4O_4.2H_2O$ |
| 15.9 | 1.7 | 34.36 | $KHC_4H_4O_4.2H_2O+KHC_4H_4O_4$ |
| 20 | 6.39 | 0 | $H_2C_4H_4O_4$ |
| 20 | 7.48 | 1.85 | " |
| 20 | 14.63 | 11.64 | " |
| 20 | 15.03 | 13.32 | " $+KH_3(C_4H_4O_4)_2$ |
| 20 | 13.32 | 18.46 | $KH_3(C_4H_4O_4)_2$ |
| 20 | 12.74 | 22.45 | " $+KHC_4H_4O_4$ |
| 20 | 11.7 | 22.91 | $KHC_4H_4O_4$ |
| 20 | 1.71 | 42.1 | " |
| 20 | 1.05 | 47.3 | " $+K_2C_4H_4O_4.3H_2O$ |
| 20 | 0.985 | 48.1 | $K_2C_4H_4O_4.3H_2O$ |
| 20 | 0.909 | 48.75 | " |
| 20 | 0.159 | 54.3 | " |
| 20 | 0 | 56.6 | " |
| 25 | 7.88 | 0 | $H_2C_4H_4O_4$ |
| 25 | 9.965 | 3.17 | " |
| 25 | 12.77 | 8.4 | " |
| 25 | 17.6 | 14.15 | " |
| 25 | 18.1 | 14.3 | " $+KH_3(C_4H_4O_4)_2$ |
| 25 | 15.36 | 18.48 | $KH_3(C_4H_4O_4)_2$ |
| 25 | 13.7 | 23.6 | " $+KHC_4H_4O_4$ |
| 25 | 13.06 | 23.81 | $KHC_4H_4O_4$ |
| 25 | 11.98 | 24.43 | " |
| 25 | 9.97 | 25 | " |
| 25 | 6.61 | 28.6 | " |
| 25 | 2.6 | 38.2 | " |
| 25 | 2.11 | 40.6 | " |
| 25 | 1.03 | 48.7 | " $+K_2C_4H_4O_4.3H_2O$ |
| 25 | 0.13 | 56.15 | $K_2C_4H_4O_4.3H_2O$ |
| 25 | 0 | 58.05 | " |
| 40 | 12.9 | 0 | $H_2C_4H_4O_4$ |
| 40 | 25.5 | 16.83 | " $+KH_3(C_4H_4O_4)_2$ |
| 40 | 19 | 25.48 | $KH_3(C_4H_4O_4)_2+KHC_4H_4O_4$ |
| 40 | 15.83 | 26.56 | $KHC_4H_4O_4$ |
| 40 | 0 | 62.10 | $K_2C_4H_4O_4.3H_2O$ |

## Solubility of Succinic Acid in Aqueous Solutions of:

(Doosaj and Bhagwat, 1933.)

Sodium Chloride at 25°

| Gms. per liter NaCl | Gms. per liter $C_4H_6O_4$ | Gms. per liter NaCl | Gms. per liter $C_4H_6O_4$ |
|---|---|---|---|
| 0.0 | 70.03 | 313.28 | 22.74 |
| 17.70 | 74.85 | 316.07 | 10.00 |
| 35.40 | 68.55 | 319.01 | 4.51 |
| 44.25 | 66.51 | 321.82 | 3.62 |
| 118.00 | 52.25 | 327.87 | 3.00 |
| 177.00 | 42.27 | 333.97 | 2.01 |
| 221.25 | 36.03 | 347.06 | 1.04 |
| 295.00 | 26.52 | 354.00 | 0.52 |

Sodium Salicylate at 14.3°

| Gms. per liter $C_6H_4(OH)COONa$ | Gms. per liter $C_4H_6O_4$ |
|---|---|
| 0.0 | 50.23 |
| 11.58 | 59.00 |
| 22.11 | 63.84 |
| 40.53 | 70.98 |
| 81.06 | 82.94 |
| 121.60 | 93.71 |
| 162.13 | 97.79 |
| 243.20 | 86.80 |

## Solubility of Succinic Acid in Aqueous and in Pure Ethyl Alcohol.

(Wright, 1927.)

| Solvent | t° | Gms. $C_4H_6O_4$ per 100 gms. solvent |
|---|---|---|
| Aq. 50 wt. % $C_2H_5OH$ | 20 | 13.7 |
| " " " " | 30 | 20.9 |
| Pure " | 20 | 10.05 |
| " " | 30 | 11.9 |

## Solubility of Succinic Acid in Aqueous Solutions of Dioxane at 25°.

(Herz and Lorentz, 1929.)

| cc Dioxane per 100 cc aq. solvent | Gm. Equiv. $C_4H_6O_4$ per liter sat. sol. | cc Dioxane per 100 cc aq. solvent | Gm. Equiv. $C_4H_6O_4$ per liter sat. sol. |
|---|---|---|---|
| 10 | 0.79 | 75 | 1.76 |
| 33 | 1.24 | 80 | 1.66 |
| 50 | 1.42 | 100 | 1.36 |
| 66 | 1.66 | | |

## Solubility of Succinic Acid in Aqueous Acetone at 20°.

(Herz and Knoch, 1904.)

| cc. Acetone per 100 cc. Solution. | $C_4H_6O_4$ per 100 cc. Solution. Millimols. | Gms. | cc. Acetone per 100 cc. Solution. | $C_4H_6O_4$ per 100 cc. Solution. Millimols. | Gms. |
|---|---|---|---|---|---|
| 0 | 107.8 | 6.363 | 60 | 275.7 | 16.27 |
| 10 | 127.4 | 7.519 | 70 | 278.5 | 16.44 |
| 20 | 155.8 | 9.194 | 80 | 265.3 | 15.66 |
| 30 | 186.7 | 11.02 | 90 | 201.9 | 11.91 |
| 40 | 225.4 | 13.30 | 100 | 51.5 | 3.04 |
| 50 | 254.3 | 15.01 | | | |

## Solubility of Succinic Acid in Aqueous Glycerol Solutions at 25°.

(Herz and Knoch, 1905.)

| Wt. % Glycerol in Solvent. | $C_4H_6O_4$ per 100 cc. Solution. Millimols. | Gms. | Sp. Gr. of Solutions. | Wt. % Glycerol in Solvent. | $C_4H_6O_4$ per 100 cc. Solution. Millimols. | Gms. | Sp. Gr. of Solutions. |
|---|---|---|---|---|---|---|---|
| 0 | 133.4 | 7.874 | 1.0213 | 40.95 | 105.8 | 6.244 | 1.1120 |
| 7.13 | 128.2 | 7.566 | 1.0407 | 48.70 | 99.9 | 5.896 | 1.1298 |
| 20.44 | 118.3 | 6.982 | 1.0644 | 69.20 | 88.5 | 5.223 | 1.1804 |
| 31.55 | 109.7 | 6.476 | 1.0897 | 100* | 74.6 | 4.440 | 1.2530 |

* Sp. Gr. of Glycerol = 1.2555. Impurity about 1.5 per cent.

### Distribution of Succinic Acid between Water and Ether at 15°, 20° and 25.5°.

(Pinnow, 1915.)

| Results at 15°. Gm. Mols. per Liter. Aqueous Layer ($c$). | Ether Layer ($c'$). | $\frac{c}{c'}$. | Results at 20°. Gm. Mols. per Liter. Aqueous Layer ($c$). | Ether Layer ($c'$). | $\frac{c}{c'}$. | Results at 25.5°. Gm. Mols. per Liter. Aqueous Layer ($c$). | Ether Layer ($c'$). | $\frac{c}{c'}$. |
|---|---|---|---|---|---|---|---|---|
| 0.474 | 0.0783 | 6.05 | 0.644 | 0.096 | 6.71 | 0.3293 | 0.0438 | 7.52 |
| 0.2585 | 0.0415 | 6.23 | 0.312 | 0.046 | 6.87 | 0.1768 | 0.0235 | 7.52 |
| 0.1175 | 0.0187 | 6.28 | 0.151 | 0.0218 | 6.93 | 0.0894 | 0.0116 | 7.71 |
| | | | 0.0405 | 0.006 | 6.75 | | | |

Very careful determinations of this distribution at 0° and at 25°, in which the ionization of the succinic acid in the two solvents is taken into consideration, are given by Chandler, 1908. Two determinations at 0° and two at 15° are quoted by Kolossovsky, 1911. Earlier data for this system are given by Nernst, "Theoretical Chemistry," 3rd English edition, p. 496.

### Distribution of Succinic Acid Between Water and Ethyl Ether.

(Forbes and Coolidge, 1919.)

| Results at 15°. Gms. $(CH_2)_2(COOH)_2$ per 100 gms. $H_2O$ layer. | $(C_2H_5)_2O$ layer. | Results at 20°. Gms. $(CH_2)_2(COOH)_2$ per 100 gms. $H_2O$ layer. | $(C_2H_5)_2O$ layer. | Results at 25° Gms. $(CH_2)_2(COOH)_2$ per 100 gms. $H_2O$ layer. | $(C_2H_5)_2O$ layer. |
|---|---|---|---|---|---|
| 2.285 | 0.5025 | 1.274 | 0.2525 | 2.273 | 0.410 |
| 2.689 | 0.592 | 2.655 | 0.528 | 4.38 | 0.804 |
| 3.475 | 0.773 | 3.03 | 0.605 | 6.44 | 1.208 |
| 5.22 | 1.182 | 3.82 | 0.768 | 8.76 | 1.214 |
| 5.68 | 1.289 | 5.57 | 1.137 | | 1.689 |
| | | 7.10 | 1.475 | | |

Calculations of the undissociated acid in each layer are also given by the authors.

Results at 19°.

(Schilow and Lepin, 1922.)

| Gms. $(CH_2)_2(COOH)_2$ per 100 cc. $H_2O$ layer ($C_1$) | $(C_2H_5)_2O$ layer ($C_2$) | $\frac{C_2}{C_1}$. |
|---|---|---|
| 0.975 | 0.133 | 0.1364 |
| 1.910 | 0.266 | 0.1393 |
| 3.940 | 0.554 | 0.1406 |
| 8.160* | 1.154* | 0.1411 |

* Sat. with $(CH_2)_2(COOH)_2$.

Results at 25°.

(Smith, 1921, 1922.)

| Millimols. $(CH_2)_2(COOH)_2$ per liter $H_2O$ layer ($C_1$). | $(C_2H_5)_2O$ layer ($C_2$). | $\frac{C_2}{C_1}$. |
|---|---|---|
| 1.600 | 0.2880 | 0.180 |
| 2.625 | 0.4875 | 0.186 |
| 4.3625 | 0.8625 | 0.1975 |
| 7.95 | 1.55 | 0.195 |
| 13.80 | 2.75 | 0.199 |

Additional data upon the distribution of succinic acid between water and ether are given by Wosnessensky, 1923, and Perschke, 1926.

### Distribution of Succinic Acid Between :

Water and Amyl Ether at 19°.

(Schilow and Lepin, 1922.)

| Gms. $(CH_2)_2(COOH)_2$ per liter of $H_2O$ layer. | Amyl ether layer. |
|---|---|
| 1.914 | 0.0355 |
| 2.675 | 0.0448 |
| 4.270 | 0.0541 |
| 4.830 | 0.0564 |
| 6.56 | 0.0708* |

Water and Chloroform at 25°.

(Smith, 1921, 1922.)

| Millimols. $(CH_2)_2(COOH)_2$ per liter of $H_2O$ layer ($C_1$). | $CHCl_3$ layer ($C_2$). | $\frac{C_2}{C_1}$. |
|---|---|---|
| 13.50 | 0.15 | 0.0110 |
| 20.50 | 0.30 | 0.0146 |
| 34.90 | 0.60 | 0.0172 |
| 48.00 | 0.95 | 0.0198 |

* Solid Phase present.

Acetone and Glycerol at 25°.

(Smith, 1921, 1922.)

| Millimols. $(CH_2)_2(COOH)_2$ per liter of Acetone layer (A). | Glycerol layer (G). | $\frac{A}{G}$. |
|---|---|---|
| 0.7625 | 1.35 | 0.565 |
| 1.325 | 1.9625 | 0.675 |
| 1.550 | 2.675 | 0.580 |
| 2.925 | 4.725 | 0.619 |
| 3.275 | 5.70 | 0.575 |

100 cc. sat. sol. of succinic acid in acetone contain 3.86 gms. $(CH_2)_2(CO\,OH)_2$ at 20°. (Viseur, 1926.)

100 gms. *p* cymene dissolve 0.02 gms. succinic acid at 25°. (Wheeler, 1920.)

Freezing-point data for mixtures of succinic acid and urea are given by Kremann, Weber and Zechner, 1925.

## Distribution of Succinic Acid between Water and Amyl Alcohol at 20°.

(Herz and Fischer, 1904.)

| Millimols $\frac{1}{2}C_4H_6O_4$ per 10 cc. | | Gms. $C_4H_6O_4$ per 100 cc. | | Millimols $\frac{1}{2}C_4H_6O_4$ per 10 cc. | | Gms. $C_4H_6O_4$ per 100 cc. | |
|---|---|---|---|---|---|---|---|
| Alcohol Layer. | Aq. Layer. | Alcohol Layer. | Aq. Layer. | Alcohol Layer. | Aq. Layer. | Alcohol Layer. | Aq. Layer. |
| 0.1888 | 0.2684 | 0.1114 | 0.1584 | 3.899 | 6.0795 | 2.302 | 3.588 |
| 0.3643 | 0.5252 | 0.215 | 0.310 | 5.199 | 8.099 | 3.069 | 4.779 |
| 0.7077 | 1.0373 | 0.418 | 0.612 | 6.334 | 10.170 | 3.739 | 6 |
| 1.440 | 2.1266 | 0.850 | 1.255 | 7.119 | 11.555 | 4.202 | 6.821 |
| 2.715 | 4.0495 | 1.603 | 2.391 | | | | |

## Distribution of Succinic Acid Between Water and Iso Amyl Alcohol at 25°.

(Kolossowsky, Kulikow and Bekturow, 1935.)

| Gm. Mols. $(CH_2)_2(COOH)_2$ per liter | | $\frac{1}{2}$ | Gm. Mols. $(CH_2)_2(COOH)_2$ per liter | | $\frac{1}{2}$ |
|---|---|---|---|---|---|
| $H_2O$ layer(1) | Alcohol layer(2) | | $H_2O$ layer(1) | Alcohol layer(2) | |
| 0.119 | 0.075 | 1.59 | 0.502 | 0.314 | 1.60 |
| 0.138 | 0.088 | 1.59 | 0.615 | 0.389 | 1.58 |
| 0.175 | 0.106 | 1.65 | 0.766 | 0.489 | 1.57 |
| 0.226 | 0.136 | 1.64 | 0.992 | 0.615 | 1.61 |
| 0.370 | 0.238 | 1.57 | 1.208 | 0.778 | 1.63 |

## Distribution of Succinic Acid Between Water and Phenol.

(Campbell and Campbell, 1937.)

| t° | Gms. $(CH_2)_2(COOH)_2$ per 100 gms. | | $\frac{2}{1}$ | t° | Gms. $(CH_2)_2(COOH)_2$ per 100 gms. | | $\frac{2}{1}$ |
|---|---|---|---|---|---|---|---|
| | $H_2O$ layer(1) | $C_6H_5OH$ layer(2) | | | $H_2O$ layer(1) | $C_6H_5OH$ layer(2) | |
| 2.0 | 3.95 | 4.05 | 1.02 | 24.5 | 4.54 | 4.47 | 1.00 |
| 10.5 | 3.98 | 4.15 | 1.04 | 29.9 | 3.87 | 3.82 | 0.99 |
| 14.5 | 3.98 | 4.10 | 1.03 | 31.0 | 4.13 | 3.95 | 0.955 |
| 19.1 | 4.10 | 4.08 | 1.00 | 34.2 | 3.79 | 3.87 | 1.02 |
| 21.7 | 4.04 | 4.05 | 1.00 | | | | |

## Solubility of Succinic Acid in Alcohols and in Ether.

(Timofeiew, 1891, 1894; at 15°, Bourgoin, 1878.)

| Solvent. | Gms. $(CH_2)_2(COOH)_2$ per 100 Gms. Solvent at: | | | |
|---|---|---|---|---|
| | −1°. | +15°. | +21.5°. | +39°. |
| Abs. Methyl Alcohol | 10.51 | ... | 19.40 | 28.7 |
| Abs. Ethyl " | 5.06 | 12.59 | 9.49 | 15 |
| 90% " " | ... | 7.51 | ... | ... |
| Abs. Propyl " | 2.11 | ... | 4.79 | 7.53 |
| Abs. Ether | ... | 1.265 | ... | ... |
| Isobutyl Alcohol | ... | ... | 2.73 | ... |

100 gms. 95 per cent formic acid dissolve 2.06 gms. $(CH_2)_2(COOH)_2$ at 18.5°. (Aschan, 1913.)

SOLUBILITY OF SUCCINIC ACID IN SEVERAL ORGANIC SOLVENTS AT 28°.
(Desai and Patel, 1935.)

| Solvent | Mol. fraction $C_4H_6O_4$ in sat. solution | Solvent | Mol. fraction $C_4H_6O_4$ in sat. solution |
|---|---|---|---|
| Acetone | 0.02948 | Nitrobenzene | 0.000128 |
| Carbon Tetrachloride | 0.0000118 | Chloroform | 0.000138 |
| Benzene | 0.00002824 | Methyl alcohol | 0.05620 |
| Toluene | 0.0000298 | Ethyl alcohol | 0.04865 |
| m Xylene | 0.0000304 | n Propyl alcohol | 0.03613 |
| Chlorobenzene | 0.0000476 | n Butyl alcohol | 0.02618 |

Data for the solubility of Succinic Acid in Acetone in presence of Maleic and of Fumaric Acids and vice versa at 20° are given by Viseur, 1926.

Diagrams showing the solubility of Succinic Acid in various binary mixtures of Water, Acetone, Carbon Tetrachloride, Methyl, Ethyl and Propyl Alcohols at 20° and at 40° are given by Bancroft and Butler, 1932.

Freezing-point data are given for mixtures of Succinic Acid and:

1.2 Dichlor ethane(4)
Di nitro phenol(1)
Fumaric Acid(3)
Hydroquinone(1)
Maleic Acid(3)(5)
α Naphthol(1)
β Naphthol(1)
α Naphthylamine(2)
β " (2)
m Nitro phenol(1)
p " "
Phenol(1)
Pyrocatechol(1)
Pyrogallol(1)
Picric Acid
Resorcinol(1)
1.1.2.2 Tetra chloro ethane(4)
Azo benzene(3)

(1) Kremann, Zechner and Drazil, 1924; (2) Kremann, Weber and Zechner 1925; (3) Kremann and Zechner, 1925; (4) Timmermans and Mme. Vesselovsky 1931; (5) Grimm, Gunther and Titus, 1931.

**METHYL MALONIC ACID** (Iso Succinic Acid) $CH(CH_3)(COOH)_2$.

100 gms. $H_2O$ dissolve 123.8 gms. $CH(CH_3)(COOH)_2$ at 25°.
" " $C_6H_6$ " 0.003 gm. " " " "

(Verkade and Coops, 1930a.)

The critical solution temperature of a mixture of methyl malonate and camphene is 74° and there is 44.6 percent methyl malonate present.

(Lecat, 1930.)

**MALIC ACID** (inactive) $COOHCH(OH)CH_2COOH$.

### Solubility of Malic Acid in Water.
(Lange and Sinks, 1930.)

From the determinations at approximately 5° intervals a curve was plotted and from this the equation $C = 0.438t + 47.04$ was derived. The following results were calculated from the authors' equation.

| t° | Gms. $C_4H_6O_5$ per 100 gms. sat. sol. | t° | Gms. $C_4H_6O_5$ per 100 gms. sat. sol. |
|---|---|---|---|
| 0 | 47.04 | 40 | 64.6 |
| 10 | 51.42 | 50 | 68.9(68.95) |
| 20 | 55.8 | 60 | 73.3(72.85) |
| 25 | 58.0(59.15 at 26°) | 70 | 77.7(76.85) |
| 30 | 60.2 | 80 | 82.1(80.65 at 79°) |

The authors also give results for the densities and refractive indices of aqueous solutions of malic acid.

The results in parentheses are by Weiss and Downs, 1923.

The solubility of laevo Malic Acid in Water is given by Timmermans and Dumont, 1931, as 26.96 gms. $C_4H_5O_5$ per 100 gms. $H_2O$ at 10° and 36.35 gms. at 20°. The eutectic point is given as at -2.20° with 15.0 gms. *l* malic acid per 100 gms. $H_2O$.

### Solubility of Malic Acid in Aqueous Solutions of Phosphoric Acid at 25°.
(Walton and Kepfer, 1930.)

| Normality of Aq. $H_3PO_4$ | Normality of $C_4H_6O_5$ in sat. sol. | Normality of Aq. $H_3PO_4$ | Normality of $C_4H_6O_5$ in sat. sol. |
|---|---|---|---|
| 0.0 | 11.06 | 23.23 | 3.02 |
| 4.96 | 8.88 | 28.94 | 2.70 |
| 15.44 | 4.74 | 32.10 | 2.72 |
| 16.76 | 4.48 | 35.81 | 2.82 |
| 20.08 | 3.68 | 38.15 | 2.95 |

### Solubility of Malic Acid in Aqueous Solutions of Sulfuric Acid at 30°.
(Dittmar, 1930.)

| Normality of Aq. $H_2SO_4$ | Normality of $C_4H_6O_5$ in sat. sol. | Normality of Aq. $H_2SO_4$ | Normality of $C_4H_6O_5$ in sat. sol. |
|---|---|---|---|
| 0.0 | 11.21 | 19.08 | 3.568 |
| 4.212 | 8.045 | 23.54 | 5.005 |
| 9.416 | 5.451 | 25.26 | 6.071 |
| 14.00 | 3.568 | 28.44 | 7.090 |

### Distribution of Malic Acid between Water and Ether. (Pinnow, 1915.)

Results at 15°.

| Gm. Mols. Acid per Liter: $H_2O$ Layer. | Ether Layer. | Dist. Coeff. |
|---|---|---|
| 0.564 | 0.0091 | 62 |
| 0.288 | 0.0045 | 64 |
| 0.151 | 0.0024 | 62.9 |
| 0.967 | 0.0157 | 61.6 |

Results at 25.5°.

| Gm. Mols. Acid per Liter. $H_2O$ Layer. | Ether Layer. | Dist. Coeff. |
|---|---|---|
| 1.179 | 0.0172 | 68.4 |
| 0.582 | 0.0082 | 71 |
| 0.293 | 0.0040 | 73 |
| 0.142 | 0.0020 | 71 |

Freezing-point data for *i* malic acid + *l* mandelic acid are given by Centnerszwer, 1899.

### Distribution of Malic Acid at 25° Between Acetone and Glycerol.
(Smith, 1921, 1922.)

| Millimols. COOH.$CH_2$.CHOH.COOH per liter of | | |
|---|---|---|
| Acetone layer (A). | Glycerol layer (G). | $\frac{A}{G}$. |
| 0.475 | 2.60 | 0.182 |
| 0.675 | 3.75 | 0.180 |
| 1.10 | 5.50 | 0.200 |
| 2.2875 | 11.0625 | 0.207 |

### Solubility of *l* Malic Acid in Several Solvents.

| | | | | | | |
|---|---|---|---|---|---|---|
| 100 gms. | methyl alcohol | dissolve | 124.8 | gms. | malic acid at | 0°. (1) |
| " " | " " | " | 167.7 | " | " " " | 19.1°. (1) |
| " " | ethyl " | " | 91.4 | " | " " " | 19°. (1) |
| " " | propyl " | " | 54 | " | " " " | 19°. (1) |
| " " | dichlorethylene | " | 0.009 | " | " " " | 15°. (2) |
| " " | trichlorethylene | " | 0.010 | " | " " " | 15° (2) |
| " " | ethyl ether | " | 2.96 | " | " " " | 20°. (3) |

(1) Timofeiew, 1894; (2) Wester & Bruins, 1894; (3) Timmermans and Dumont, 1931.

Freezing-point data are given for mixtures of:

| | |
|---|---|
| d Malic Acid + l Malic acid(1) | l Malic Acid + Meso Tartaric acid(2) |
| " " + d Chlorosuccinic acid(2) | " " + d Phenyl glycollic |
| " " + l " " " (2) | " + acid(3) |
| " " + d Tartaric acid(2)(4) | " " + l " " |
| " " + l " " (2)(4) | " " + d Tartaric acid + $H_2O$(4) |
| | " " + l " " " |

(1) Timmermans and Mme. Vesselovsky, 1932; (2) Timmermans and Meuse, 1931; (3) Timmermans and Motuik, 1932; (4) Timmermans and Dumont, 1931.

## TARTARIC ACIDS $C_2H_2(OH)_2(COOH)_2$. *d*, *l*, and *racemic*

### Solubility of Each Separately in Water.
(Leidie, 1882.)

| t°. | Grams Tartaric Acid per 100 Gms. $H_2O$. | | | t°. | Gms. Tartaric Acid per 100 Gms. $H_2O$. | | |
|---|---|---|---|---|---|---|---|
| | Dextro and Laevo Acids. | Racemic Ac. Anhydrous. | Racemic Ac. Hydrated. | | Dextro and Laevo Acids. | Racemic Ac. Anhydrous. | Racemic Ac. Hydrated |
| 0 | 115.04 | 8.16 | 9.23 | 50 | 195.0 | 50.0 | 59.54 |
| 10 | 125.72 | 12.32 | 14.00 | 60 | 217.55 | 64.52 | 78.33 |
| 20 | 139.44 | 18.0 | 20.60 | 70 | 243.66 | 80.56 | 99.88 |
| 25 | 147.44 | 21.4 | 24.61 | 80 | 273.33 | 98.12 | 124.56 |
| 30 | 156.2 | 25.2 | 29.10 | 90 | 306.56 | 117.20 | 152.74 |
| 40 | 176.0 | 37.0 | 43.32 | 100 | 343.35 | 137.80 | 184.91 |

100 gms. $H_2O$ dissolve 140.8 gms. tartaric acid at 15°. The Sp. Gr. of the sat. solution is 1.31.
(Greenish and Smith, 1902.)

The following results for the solubility at 25° of dextro tartaric acid, racemic tartaric acid and mixtures of the two are given by Findlay and Campbell, 1928.

| Acid | Gms. acid per 100 gms. $H_2O$ |
|---|---|
| Dextro Tartaric Acid | 147.7 |
| Racemic (d + l) Tartaric Acid | 21.5 |
| Dextro + Racemic " " | 103.8(d) + 11.8(l) |

Later very careful determinations by Dalman, 1937, differing somewhat from the results of Leidie, 1882, correspond to a straight line expressed by the equation C = 51.8573 + 0.2643 t. From this equation the following results were obtained.

| t° | Gms. $C_4H_6O_6$ per 100 gms. sat. sol. | Solid Phase | t° | Gms. $C_4H_6O_6$ per 100 gms. sat. sol. | Solid Phase |
|---|---|---|---|---|---|
| -16.18 Eutec. | 48.18 (1) | Ice + $C_4H_6O_6$ | 50 | 65.072 | $C_4H_6O_6$ |
| 0 | 51.8573 | $C_4H_6O_6$ | 60 | 67.715 | " |
| 10 | 54.490 | " | 70 | 70.358 | " |
| 20 | 57.143 | " | 80 | 73.001 | " |
| 25 | 58.464 | " | 90 | 75.644 | " |
| 30 | 59.786 | " | 100 | 78.287 | " |
| 40 | 62.429 | " | | | |

(1) Timmermans and Dumont, 1931.

## TARTARIC ACID $C_2H_2(OH)_2(COOH)_2$.

Solubility of Tartaric Acid in Aqueous Solutions of Acetic Acid, Hydrochloric Acid and of Sulfuric Acid at 25°. (Knox and Richards, 1919.)

Results for Acetic Acid.

| Equiv. Normality | |
|---|---|
| $CH_3COOH$. | $C_2H_2(OH)_2(COOH)_2$. |
| 0.25 | 10.09 |
| 0.60 | 9.875 |
| 1.23 | 9.515 |
| 2.63 | 8.717 |
| 4.25 | 7.718 |
| 6.12 | 6.548 |
| 8.30 | 5.151 |
| 10.89 | 3.505 |
| 14.14 | 1.594 |
| 16.92 | 0.344 |

Results for Hydrochloric Acid.

| Equiv. Normality | |
|---|---|
| HCl. | $C_2H_2(OH)_2(COOH)_2$. |
| 0.0 | 10.260 |
| 1.257 | 8.528 |
| 2.568 | 7.092 |
| 4.466 | 5.434 |
| 6.303 | 4.350 |
| 8.144 | 3.77 |
| 9.89 | 3.43 |
| 10.51 | 3.42 |
| 11.17 | 3.42 |

Results for Sulfuric Acid.

| Equiv. Normality | |
|---|---|
| $H_2SO_4$. | $C_2H_2(OH)_2(COOH)_2$. |
| 1.798 | 8.51 |
| 4.043 | 6.64 |
| 6.807 | 4.73 |
| 9.895 | 3.18 |
| 12.54 | 2.43 |
| 15.46 | 1.95 |
| 18.10 | 1.77 |
| 19.85 | 1.86 |
| 22.17 | 2.74 |

Solubility of Tartaric Acid in Aqueous Ethyl Alcohol Solutions at 25°. (Seidell, 1910.)

| Wt. Per cent $C_2H_5OH$ in Solvent. | $d_{25}$ of Sat. Sol. | Gms. $C_2H_2(OH)_2(COOH)_2$ per 100 Gms. | | Wt. Per cent $C_2H_5OH$. in Solvent. | $d_{25}$ of Sat. Sol. | Gms. $C_2H_2(OH)_2(COOH)_2$ per 100 Gms. | |
|---|---|---|---|---|---|---|---|
| | | Sat. Sol. | Solvent. | | | Sat. Sol. | Solvent. |
| 0 | 1.321 | 57.9 | 137.5 | 60 | 1.142 | 43.9 | 78.3 |
| 10 | 1.300 | 56 | 127.3 | 70 | 1.095 | 40.2 | 66.9 |
| 20 | 1.276 | 54.1 | 117.9 | 80 | 1.040 | 35.3 | 54.6 |
| 30 | 1.251 | 52 | 108.3 | 90 | 0.973 | 29 | 40.8 |
| 40 | 1.220 | 49.6 | 98.4 | 95 | 0.937 | 25.4 | 34.1 |
| 50 | 1.184 | 47 | 88.6 | 100 | 0.905 | 21.6 | 27.6 |

## Solubility of Dextro Tartaric Acid, Racemic Tartaric Acid and Mixtures of the two in 93.8 Wt. Ethyl Alcohol.

(Findlay and Campbell, 1928.)

| Solid Phase | Gms. $C_4H_6O_6$ per 100 gms. 93.8 Wt. % $C_2H_5OH$ at: 0° | 15° | 25° | 40° |
|---|---|---|---|---|
| Dextro acid | 25.17 | 30.65 | 43.04 | 61.70 |
| Racemic acid (total d + l) | 2.006 | 3.153 | 5.01 | 6.299 |
| Dextro + racemic acid | 24.92d | 40.26d | 51.06d | 94.04d |
| | 1.091 | 0.21 | 1.041 | 1.581 |

The authors also give similar results for dextro and racemic Methyl Tartrate, Methyl Diacetyl tartrate, Ethyl Diacetyl tartrate and Methyl Dibenzyl tartrate.

## Solubility of Tartaric Acid in Aqueous Solutions of Salts at 25°.

(Herz and Hiebenthal, 1929.)

In aq. Potassium Chloride

| Gm. Equiv. per liter KCl | $C_4H_6O_6$ |
|---|---|
| 0.0 | 10.04 |
| 1.0 | 9.92 |
| 1.68 | 9.92 |
| 2.25 | 9.90 |
| 2.70 | 9.90 |

In aq. Sodium Chloride

| Gm. Equiv. per liter NaCl | $C_4H_6O_6$ |
|---|---|
| 0.75 | 9.94 |
| 1.20 | 9.84 |
| 1.52 | 9.78 |
| 1.70 | 9.78 |
| 3.70(1) | 9.77 |

(1) An excess of NaCl was present.

## Distribution of Tartaric Acid between Water and Ether.

(Pinnow, 1915.)

Results at 15°.

| Gms. Mols. per Liter. $H_2O$ Layer, $c$. | Ether Layer, $c'$. | $\frac{c}{c'}$. |
|---|---|---|
| 1.402 | 0.0072 | 197 |
| 0.790 | 0.0037 | 216 |
| 0.446 | 0.0022 | 210 |

Results at 27°.

| Gms. Mols. per Liter. $H_2O$ Layer, $c$. | Ether Layer, $c'$. | $\frac{c}{c'}$. |
|---|---|---|
| 1.625 | 0.0070 | 233 |
| 0.857 | 0.0033 | 259 |
| 0.427 | 0.0016 | 268 |

## Distribution of Tartaric Acid Between Water and Iso Amyl Alcohol at 25°.

(Kolossowsky, Kulikow and Bekturow, 1936.)

| Gm. Mols. $C_4H_6O_6$ per liter $H_2O$ layer(1) | Alcohol layer(2) | $\frac{1}{2}$ | Gm. Mols. $C_4H_6O_6$ per liter $H_2O$ layer(1) | Alcohol layer(2) | $\frac{1}{2}$ |
|---|---|---|---|---|---|
| 0.454 | 0.029 | 15.66 | 4.44 | 0.52 | 8.54 |
| 0.674 | 0.047 | 14.34 | 5.42 | 0.72 | 7.53 |
| 1.370 | 0.114 | 12.02 | 6.83 | 0.98 | 6.97 |
| 2.010 | 0.198 | 10.15 | 8.48 | 1.57 | 5.40 |
| 2.600 | 0.255 | 10.20 | 10.51 | 2.80 | 3.75 |

### Distribution of Tartaric Acid Between

Water and Ether.

Results at 19°. (Schilow and Lepin, 1922.)

| Gms. $C_2H_2(OH)_2(COOH)_2$ per 100 cc. of | | |
|---|---|---|
| $H_2O$ layer ($C_1$). | $(C_2H_5)_2O$ layer ($C_2$). | $\frac{C_2}{C_1}$. |
| 16.70 | 0.0742 | 0.0044 |
| 33.60 | 0.154 | 0.0046 |
| 66.80 | 0.367 | 0.0055 |
| 107.4 | 0.890 | 0.0083 |
| 137.0* | 1.600* | 0.0117 |

Results at 25°. (Smith, 1921, 1922.)

| Millimols. $C_2H_2(OH)_2(COOH)_2$ per liter of | | |
|---|---|---|
| $H_2O$ layer ($C_1$). | $(C_2H_5)_2O$ layer ($C_2$). | $\frac{C_2}{C_1}$. |
| 8.40 | 0.625 | 0.0745 |
| 21.62 | 1.500 | 0.0694 |
| 37.55 | 2.562 | 0.0683 |
| 98.75 | 6.062 | 0.0613 |

* Excess solid present.

Acetone and Glycerol.

Results at 25°. (Smith, 1921, 1922.)

| Millimols. $C_2H_2(OH)_2(COOH)_2$ per liter of | | |
|---|---|---|
| Acetone layer (A). | Glycerol layer (G) | $\frac{A}{G}$. |
| 0.412 | 2.75 | 0.150 |
| 0.445 | 3.07 | 0.136 |
| 0.625 | 5.77 | 0.105 |
| 0.60 | 6.00 | 0.100 |
| 1.30 | 16.75 | 0.080 |

100 gms. 86.5 % glycerol ($d = 1.2326$) dissolve 115.5 — 161.7 gms. $C_2H_2(OH)_2(COOH)_2$ at 20°.

100 gms. 98.5 % glycerol ($d = 1.2645$) dissolve 69.5 — 114.7 gms. $C_2H_2(OH)_2(COOH)_2$ at 20°.

Saturation was approached from below and from above. In the latter case esters were formed and the higher results include the acid which had passed into solution in the form of ester. (Hölm, 1921, 1922.)

### Solubility of Tartaric Acid in Alcohols.

(Timofeiew, 1894.)

| Alcohol. | t°. | Gms. $C_2H_2(OH)_2(COOH)_2$ per 100 Gms. Solvent. |
|---|---|---|
| Methyl Alcohol | − 3 | 67.5 |
| " | +19.2 | 70.1 |
| " | 23 | 73.2 |
| " | 39 | 77.3 |
| Ethyl Alcohol | − 3 | 22.4 |
| " | +19.2 | 27.6 |
| Ethyl Alcohol | +23 | 28.9 |
| " | 39 | 31.8 |
| Propyl Alcohol | − 3 | 8.74 |
| " | +19.2 | 10.85 |
| " | 23 | 11.85 |
| " | 39 | 14.4 |

### Solubility of Tartaric Acid in Several Solvents.

| Solvent. | Sp. Gr. of Solvent. | $d_{25}$ of Sat. Sol. | t°. | Gms. $C_2H_2(OH)_2(COOH)_2$ per 100 Gms. Solvent. | Authority. |
|---|---|---|---|---|---|
| Amyl Alcohol | $d_{20} = 0.817$ | 0.824 | 25 | 3.50 | (Seidell, 1910.) |
| Benzene | $d_{25} = 0.873$ | 0.875 | 25 | 0.0086 | " |
| Carbon Tetrachloride | $d_{25} = 1.587$ | 1.589 | 25 | 0.0189 | " |
| Ether | $d_{22} = 0.711$ | 0.715 | 25 | 0.61 | " |
| " | ... | ... | 15 | 0.40 | (Bourgoin, 1878.) |
| Dichlorethylene | ... | ... | 15 | 0.005 | (Wester & Bruins, '14.) |
| Trichlorethylene | ... | ... | 15 | 0.005 | " |

100 gms. Ethyl Ether dissolve 0.310 gm. dextro tartaric acid at 20°.
" " " " " 0.313 " laevo " " " "
(Timmermans and Dumont, 1931.)

F.-pt. data are given for mixtures of the *d* and *racemic* modifications of dimethyl ether of tartaric acid, and for mixtures of the *d* and *racemic* modifications of dimethyl ether of diacetyl tartaric acid by Roozeboom (1899). Results for mixtures of the *d* and *i* forms of the diformalic derivative of *racemic* tartaric acid by Ringer (1902). Results for mixtures of *d* tartaric acid and *racemic* acid ester and for *d* diacetyl tartrate and *racemic* acid ester are given by Beck (1904). Data for mixtures of *d* and *l* tartaric acid and for mixtures of *d* and *i* dimethyl ester of tartaric acid are given by Centnerszwer (1899).

Data for the melting-points of mixtures of dextro and laevo tartaric acids are given by Findlay and Campbell, 1928. The authors also give data for the freezing- or melting-points of active and racemic methyl diacetyl tartrates. ethyl diacetyl tartrates, methyl dipropionyl tartrates and methyl dibenzoyl tartrates.

**TARTARIC ACID**

Freezing-point data are given for various mixtures of:

d, l and racemic Tartaric Acids(2)(3)
" " " " " + malic acids(3)(5)
" " " " " + " " + $H_2O$(5)
" " " " " + chloro succinic acids(3)(1)(5)
" " " " " + " " " + $H_2O$(5)
" " " " " + aspartic acid(3)
" " " " " + asparigine + $H_2O$(3)
" " " " " + iso butyl ester(6)
" " " " " + phenyl glycolic ester(4)
" " " " " + " " " + $H_2O$(4)

(1) Timmermans and Mme. Vessolovsky, 1931; (2) Timmermans and Mme. Vessolovsky, 1932; (3) Timmermans and Heuse, 1931; (4) Timmermans and Motiuk, 1932; (5) Timmermans and Dumont, 1931; (6) Campbell, 1929.

**ERYTHRITOL TETRA NITRATE** i (Nitroerythrite) $(CHNO_3CH_2NO_3)_2$.

Freezing-point data for mixtures of Erythritol Tetranitrate and each of the following compounds: Nitromannite, nitro penta erythrite, nitro phenetol, p nitro toluene, 2.4.6 tri nitro toluene and m dinitro benzene are given by Urbanski, 1933, 1934.

**BUTYRO NITRILE** $CH_3(CH_2)_2CN$.

Freezing-point data are given by Joukovsky, 1934, for mixtures of Butyro nitrile with Acetonitrile, Proprio nitrile, Valeronitrile and with Benzene

**BUTYL CHLORALDEHYDE** $CH_2Cl(CH_2)_2CHO$.

Freezing-point data for mixtures of Butyl chloraldehyde and Pyramidon are given by Pfeiffer and Seydel, 1928.

**BUTYL CHLORAL HYDRATE** $CH_3CHClCCl_2CH(OH)_2$.

Freezing-point data for mixtures of Butyl chloral hydrate and Antipyrine are given by Pfeiffer and Seydel, 1929.

## ChloroACETIC ACID ESTERS.

### Solubility of Monochlor, Dichlor, and of Trichloracetic Ester in Aqueous Alcohol at Room Temperature.

(Bancroft — Phys. Rev. 3, 193, 1895-96, from results of Pfeiffer, Z. physik. chem. 9, 469, '92.)

| cc. Ethyl Alcohol in Mixtures. | cc. $H_2O$ added to cause separation of a second phase in mixtures of the given amts. of Alcohol and 3 cc. of: | | |
|---|---|---|---|
| | $CH_2ClCOOC_2H_5$. | $CHCl_2COOC_2H_5$ | $CCl_3COOC_2H_5$. |
| 3 | 1.32 | 0.90 | 0.65 |
| 6 | 4.01 | 2.45 | 1.80 |
| 9 | 7.30 | 4.33 | 3.02 |
| 12 | 10.78 | 6.60 | 4.50 |
| 15 | 16.16 | 9.20 | 6.50 |
| 18 | 22.16 | ... | ... |
| 21 | 28.74 | ... | ... |

## METHYL PROPIONATE $C_2H_4COOCH_3$.

100 gms. $H_2O$ dissolve 5 gms. $C_2H_5COOCH_3$ at 22°. (Traube, 1884.)

More recent data for the solubility of methyl propionate in water are given by Herz (1917).

## α BROMO n BUTYRIC ACID $CH_3CH_2CHBrCOOH$.

### Distribution of α Bromo n Butyric Acid at 25° Between:

(Smith and White, 1929.)

| Water and Chloroform | | Water and Benzene | | Water and Toluene | |
|---|---|---|---|---|---|
| Gm. Mols. $C_4H_7O_2Br$ per liter | | Gm. Mols. $C_4H_7O_2Br$ per liter | | Gm. Mols. $C_4H_7O_2Br$ per liter | |
| $H_2O$ layer | $CHCl_3$ layer | $H_2O$ layer | $CHCl_3$ layer | $H_2O$ layer. | $CHCl_3$ layer |
| 0.00746 | 0.00667 | 0.00786 | 0.00471 | 0.00887 | 0.00377 |
| 0.00952 | 0.00957 | 0.01010 | 0.00669 | 0.01138 | 0.00541 |
| 0.01199 | 0.01391 | 0.01153 | 0.00795 | 0.01290 | 0.00658 |
| 0.01387 | 0.01750 | 0.01307 | 0.00962 | 0.01469 | 0.00800 |
| 0.01553 | 0.02069 | 0.01547 | 0.01248 | 0.01737 | 0.01058 |
| 0.01706 | 0.02404 | 0.01744 | 0.01523 | 0.01964 | 0.01303 |
| 0.01900 | 0.02914 | 0.02134 | 0.02051 | 0.02386 | 0.01799 |
| 0.02164 | 0.03621 | 0.02838 | 0.03272 | 0.03190 | 0.02920 |
| 0.02428 | 0.04352 | 0.03778 | 0.05257 | 0.04215 | 0.04820 |
| 0.02689 | 0.05101 | | | | |

### Distribution of α Bromo Butyric Acid Between Water and Olive Oil at 25°.

(Bodansky and Meigs, 1932.)

| Gm. Mols. $C_4H_7O_2Br$ per liter | | $\frac{1}{2}$ |
|---|---|---|
| $H_2O$ layer (1) | Oil layer (2) | |
| 0.0456 | 0.059 | 0.77 |
| 0.088 | 0.125 | 0.704 |

γ Phospho *n* **BUTYRIC ACID** $HOOC.CH_2.CH.CH_2PO(OH)$.

100 gms. sat. solution of γ phospho *n* butyric acid in water contain 41.3 gms. $HO\,OC.CH_2.CH.CH_2.PO\,(OH)$ at 0° and 53.3 gms. at 20°. (Nylen, 1926.)

**β MALAMINIC ACID** $CH_2(OH)COOH:CH_2CONH_2$, $CH_2COO.NH_4.CHCOOH$.

SOLUBILITY IN WATER AT 18°. (Lutz, 1902.)

| Compound. | M.-pt. | Gms. per 100 Gms. $H_2O$. | $(\alpha)_D$ in Water $C=1$, $l=2$. |
|---|---|---|---|
| *d* β Malaminic Acid | 149 | 7.52 | +9.70 |
| *l* " | 149 | 7.50 | −9.33 |
| *r* " | 148 | 4.02 | ... |

l and dl **ASPARTIC ACIDS** $HOOCC_2H_3(NH_2)COOH$.

SOLUBILITY OF l AND OF dl ASPARTIC ACID, EACH DETERMINED SEPARATELY, IN WATER.
(Dalton and Schmidt, 1933.)

In the case of the l Aspartic Acid 38 determinations were made at 9 temperatures between 0° and 60°. In the case of the dl acid 30 determinations were made at 9 temperatures between 0° and 65°. From the solubility equations obtained from these results the following values for regular intervals of temperature were derived. The values above 65° are less accurate than those below. The density of approximately saturated solutions at 25° was very close to 1.00.

| t° | Gms. per 100 gms. $H_2O$ | | t° | Gms. per 1000 gms. $H_2O$ | |
|---|---|---|---|---|---|
| | l aspartic acid | dl aspartic acid | | l aspartic acid | dl aspartic acid |
| 0 | 2.09(2.23) | 2.62(3.16) | 45 | 10.07 | 16.75 |
| 5 | 2.49 | 3.22 | 50 | 11.99(12.54) | 20.00(20.98) |
| 10 | 2.96 | 4.12 | 55 | 14.29 | 23.75 |
| 15 | 3.53 | 5.12 | 60 | 17.01 | 28.64 |
| 20 | 4.20 | 6.33 | 65 | 20.27 | 32.91 |
| 25 | 5.00(5.39) | 7.78(8.16) | 70 | 24.14 | 38.40 |
| 30 | 5.96 | 9.50 | 75 | 28.75(27.14) | 44.56(47.94) |
| 35 | 7.10 | 11.55 | 100 | 68.93(48.8) | 85.94(99.4) |
| 40 | 8.45 | 13.95 | | | |

The above results in parentheses are by Dunn, Ross and Reed, 1933. Those at 100° were calculated.

SOLUBILITY OF dl ASPARTIC ACID IN AQUEOUS SOLUTIONS OF ETHYL ALCOHOL.
(Dunn and Ross, 1938.)

| t° | Wt. % $C_2H_5OH$ in aqueous solvent | d. of sat. sol. | Gms. $C_4H_7O_4N$ per 100 gms. solvent | t° | Wt. % $C_2H_5OH$ in aqueous solvent | d. of sat. sol. | Gms. $C_4H_7O_4N$ per 100 gms. solvent |
|---|---|---|---|---|---|---|---|
| 0 | 20.32 | 0.972 | 0.0703 | 45 | 20.16 | 0.958 | 0.680 |
| " | 42.52 | 0.935 | 0.0267 | " | 42.59 | 0.914 | 0.255 |
| " | 66.94 | 0.886 | 0.0111 | " | 67.03 | 0.856 | 0.0608 |
| 25 | 20.00 | 0.963 | 0.266 | " | 92.61 | 0.796 | 0.0042 |
| " | 42.66 | 0.926 | 0.0992 | 65 | 20.32 | 0.952 | 1.53 |
| " | 67.03 | 0.872 | 0.0317 | " | 42.52 | 0.902 | 0.588 |
| " | 92.61 | 0.807 | 0.0020 | " | 66.94 | 0.840 | 0.132 |
| | | | | " | 92.61 | 0.780 | 0.0129 |

### Solubility of l Aspartic Acid in Aqueous Solutions of Ethyl Alcohol at 25°(?).

(McMeekin, Cohn and Weare, 1935.)

| Vol. % $C_2H_5OH$ in aqueous solvent | d. of sat. sol. | Gm. Mols. $C_4H_7O_4N$ per liter sat. sol. | Vol. % $C_2H_5OH$ in aqueous solvent | d. of sat. sol. | Gm. Mols. $C_4H_7O_4N$ per liter sat. sol. |
|---|---|---|---|---|---|
| 0.0 | 0.9994 | 0.0375 | 70.0 | 0.8826 | 0.00149 |
| 20.0 | 0.9729 | 0.0149 | 80.0 | 0.8550 | 0.00070 |
| 40.0 | 0.9457 | 0.00675 | 90.0 | 0.8262 | 0.00021 |
| 50.0 | 0.9272 | 0.00441 | 100.0 | 0.7851 | 0.0000116 |
| 60.0 | 0.9064 | 0.00264 | | | |

**l'ASPARTIC ACID** (Aspariginic Acid) Amino Succinic Acid, HOOC.$CH_2$.CH.$NH_2$.COOH.

### Solubility in Water and in Aqueous Solutions of Salts at 20°.

(Pfeiffer and Würgler, 1916.)

| Salt. | Mols. salt per liter. | Gms. $C_4H_7NO_4$ per 100 cc. sat. sol. | Salt. | Mols. salt per liter. | Gms. $C_4H_7NO_4$ per 100 cc. sat. sol. |
|---|---|---|---|---|---|
| None (= $H_2O$). . | 0.00 | 0.410 | $BaCl_2$. . . . . | 0.500 | 0.691 |
| Li Cl. . . . . | 1.17 | 0.493 | $CaCl_2$. . . . . | 0.429 | 0.612 |
| $KNO_3$. . . . . | 1.00 | 0.633 | » . . . . . | 0.528 | 0.638 |
| KCl. . . . . | 1.00 | 0.540 | » . . . . . | 0.858 | 0.745 |
| KBr. . . . . | 0.50 | 0.499 | » . . . . . | 1.716 | 0.998 |
| » . . . . . | 1.00 | 0.550 | $Ca(NO_3)_2$. . . . . | 0.49 | 0.758 |
| » . . . . . | 2.00 | 0.638 | $SrBr_2$. . . . . | 0.486 | 0.638 |
| » . . . . . | 4.00 | 0.742 | $SrCl_2$. . . . . | 0.500 | 0.638 |
| $K_2SO_4$. . . . . | 0.50 | 0.686 | $Sr(NO_3)_2$. . . . . | 0.204 | 0.592 |
| NaCl. . . . . | 0.50 | 0.464 | » . . . . . | 0.408 | 0.751 |
| » . . . . . | 1.00 | 0.520 | » . . . . . | 0.500 | 0.798 |
| » . . . . . | 2.00 | 0.541 | » . . . . . | 0.816 | 0.929 |
| » . . . . . | 4.00 | 0.570 | » . . . . . | 1.632 | 1.346 |

The following determinations are given for salt solutions made with aqueous 0.1 normal Na OH instead of water.

| Salt. | Mols. salt per liter. | Gms. $C_4H_7NO_4$ per 100 cc. sat. sol. | Salt. | Mols. salt per liter. | Gms. $C_4H_7NO_4$ per 100 cc. sat. sol. |
|---|---|---|---|---|---|
| None (=0.1*n* NaOH). | 0.0 | 1.669 | KBr. . . . . | 2.0 | 1.762 |
| Li Cl. . . . . | 1.97 | 1.640 | KCl. . . . . | 2.0 | 1 756 |
| NaCl. . . . . | 2.00 | 1.707 | $KNO_3$. . . . . | 2.0 | 1.907 |

Freezing-point data are given for:

Aspartic Acid + Chloro succinic acid + $H_2O$ (Timmermans and Heuse, 1931.)
" " + Tartaric acid (Timmermans and Mme. Vesselovsky, 1932.)

**BUTYLENE**, pseudo and iso, $C_4H_8$.

1.0 cc. abs. $C_2H_5OH$ dissolves 49.7 to 52.9 cc. pseudo $C_4H_8$ at 19° and 760 mm. pressure
1.0 cc. » » » 44.6 to 45.1 cc. iso » » » »
(Spörry, 1922, 1926.)

γ **BUTYLENE** (Propene, 2- methyl) $CH_2:C(CH_3)CH_3$.

SOLUBILITY OF γ BUTYLENE IN SEVERAL SOLVENTS AT VARIOUS TEMPERATURES AND PRESSURES.
(Kirejew, Kaplan and Romantchouk, 1939.)

| Solvent | t° | cc $C_4H_8$ (reduced to 0° & 760 mm) dissolved by 1·cc solvent at: 50 | 100 | 150 | 200 | 300 | 400 | 600 | 760 mm Hg Pressure |
|---|---|---|---|---|---|---|---|---|---|
| Kerosene | -21 | 17.5 | 36.0 | 54.5 | 73.5 | — | — | — | — |
| " | -10 | 7.5 | 15.5 | 25.5 | 39.0 | — | — | — | — |
| " | 0 | 5.5 | 11.5 | 18.0 | 25.5 | 42.5 | — | — | — |
| " | +20 | 3.0 | 6.0 | 8.5 | 11.5 | 18.0 | 25.5 | 44.0 | 58.5 |
| " | 40 | 1.0 | 2.0 | 3.0 | 4.3 | 8.0 | 11.5 | 19.0 | 24.0 |
| Xylene | -21 | 20.0 | 44.0 | 74.0 | — | — | — | — | — |
| " | -10 | 12.0 | 34.0 | 38.5 | 55.0 | — | — | — | — |
| " | 0 | 8.6 | 17.5 | 27.5 | 38.0 | 65.5 | — | — | — |
| " | +20 | 3.0 | 7.0 | 11.0 | 14.0 | 23.0 | 35.0 | 58.5 | 75.0 |
| " | 40 | 2.0 | 4.5 | 6.0 | 9.0 | 13.5 | 18.5 | 30.5 | 39.0 |
| Cracked benzine | -21 | 16.0 | 46.0 | 61.5 | — | — | — | — | — |
| " " | -10 | 9.5 | 21.5 | 35.0 | 52.0 | — | — | — | — |
| " " | 0 | 7.5 | 15.5 | 24.0 | 32.5 | 55.0 | — | — | — |
| " " | +20 | 2.0 | 5.0 | 8.0 | 11.5 | 20.0 | 29.0 | 48.5 | 61.0 |
| " " | 40 | 2.0 | 4.0 | 6.0 | 8.0 | 12.0 | 16.0 | 24.0 | 31.0 |
| Dichloro ethane | 0 | 6.0 | 12.0 | 18.0 | 24.0 | 50.0 | — | — | — |
| Light benzine | 0 | 6.0 | 12.0 | 19.0 | 28.0 | 38.0(25°) | — | — | — |
| Heavy benzine | 0 | 8.0 | 16.0 | 24.0 | 33.0 | 44.0(25°) | — | — | — |

ββ′ Dichlor **ETHYL SULFIDE** ( « Mustard Gas » ) $S(CH_2.CH_2Cl)_2$

SOLUBILITY OF « MUSTARD GAS » IN WATER.
(Boulin and Simon, 1920; Wilson, Fuller and Schur, 1922.)

B and S titrated the acidity of the aqueous solution immediately and after 24 hours and considered the results to show the amount of the compound which dissolved and afterwards decomposed. Approximate determinations in this manner, using cold water, gave 0.48 gm. S $(CH_2.CH_2Cl)_2$ per liter.

The rate of decomposition at temperatures of 20°, 50° and 100° was found to be approximately as 1 : 7.5 : 30. The effect of alkalis and of thiodiglycol on this decomposition was studied.

W, F and S shook « mustard gas » vigorously with water at 25° for 30 seconds and filtered the mixture during the next 20 seconds with the aid of suction. The result of several determinations was 0.0043 gm. mols or 0.684 gm. S $(CH_2CH_2Cl)_2$ per liter at 25°.

### The Mutual Solubility of « Mustard Gas » and Ethyl Alcohol.
(Thompson, Black and Sohl, 1921.)

The synthetic method was used. The temperatures of complete solution and of clouding of known mixtures were determined.

Results with 92.5 % Alcohol.

| t° | Gms. $S(CH_2CH_2Cl)_2$ per 100 gms. of mixture. | t°. | Gms. $S(CH_2CH_2Cl)_2$ per 100 gms. of mixture. |
|---|---|---|---|
| 5.1..... | 21.64 | 34.4..... | 65.27 |
| 12.8..... | 26.20 | 35.2..... | 68.67 |
| 17.0..... | 30.26 | 35.8..... | 72.45 |
| 21.7..... | 33.91 | 36.7..... | 75.22 |
| 25.6..... | 38.70 | 37.6..... | 78.20 |
| 28.3..... | 42.80 | 37.9..... | 81.42 |
| 29.9..... | 46.47 | 38.6..... | 84.93 |
| 30.6..... | 49.66 | 38.5..... | 86.80 |
| 31.4..... | 52.29 | 38.4..... | 88.75 |
| 31.0..... | 54.45 | 37.8..... | 90.80 |
| 32.5..... | 56.76 | 35.7..... | 92.93 |
| 33.0..... | 59.37 | 30.9..... | 95.18 |
| 33.6..... | 62.18 | 19.9..... | 97.53 |

Results with Absolute Alcohol.

| t°. | Gms. $S(CH_2CH_2Cl)_2$ per 100 gms. of mixture. |
|---|---|
| 5.6..... | 44.83 |
| 7.5..... | 47.45 |
| 9.1..... | 50.39 |
| 10.6..... | 53.73 |
| 11.8..... | 57.52 |
| 12.2..... | 61.91 |
| 13.6..... | 67.00 |
| 14.2..... | 71.75 |
| 14.8..... | 75.76 |
| 15.5..... | 80.25 |
| 15.6..... | 83.12 |
| 15.3..... | 87.13 |
| 14.8..... | 91.04 |
| 14.5..... | 93.13 |
| 13.6..... | 95.31 |

### Solubility of « Mustard Gas » in Gasoline, in Rail Road Light Oil and in Kerosene.
(Thompson and Odeon, 1920.)

Gasoline + $S(CH_2CH_2Cl)_2$.

| t° | Gms. $S(CH_2CH_2Cl)_2$ per 100 gms. of mixture. |
|---|---|
| 4.2..... | 30.08 |
| 4.5..... | 30.14 |
| 9.0..... | 36.46 |
| 9.5..... | 36.51 |
| 13.5..... | 46.21 |
| 14.0..... | 46.32 |
| 18.7..... | 53.49 |
| 20.4 (crit.t.). | 66.02 |
| 18.0..... | 77.53 |
| 7.8..... | 87.17 |
| 7.3..... | 87.34 |

R. R. Light Oil + $S(CH_2CH_2Cl)_2$.

| t°. | Gms. $S(CH_2CH_2Cl)_2$ per 100 gms. of mixture |
|---|---|
| 9.3..... | 21.64 |
| 14.5..... | 24.33 |
| 20.9..... | 29.88 |
| 23.6..... | 38.49 |
| 33.0..... | 47.95 |
| 35.0..... | 54.48 |
| 37.0 (crit.t.). | 63.80 |
| 31.3..... | 86.58 |
| 28.0..... | 88.74 |
| 25.0..... | 90.78 |

Kerosene + $S(CH_2CH_2Cl)_2$.

| t°. | Gms. $S(CH_2CH_2Cl)_2$ per 100 gms. of mixture. |
|---|---|
| 9.5..... | 33.13 |
| 14.2..... | 39.79 |
| 25.0..... | 68.67 |
| 25.6 (crit.t.). | 73.80 |
| 25.6..... | 75.21 |
| 25.6..... | 76.67 |
| 24.3..... | 81.42 |
| 21.9..... | 84.93 |
| 14.3..... | 89.68 |
| 8.9..... | 91.88 |

### Mutual Solubility of « Mustard Gas » and Ligroin.
(Thompson and Odeen, 1920.)

The ligroin boiled below 100° and had $d_{24} = 1.6677$.

| t°. | Gms. $S(CH_2CH_2Cl)_2$ per 100 gms. mixture. |
|---|---|
| — 7.5..... | 8.7 |
| — 6.5..... | 11.3 |
| — 2.5..... | 13.7 |
| + 0.2..... | 16.1 |
| 2.5..... | 24.2 |
| 6.5..... | 27.8 |
| 10.3..... | 32.5 |
| 14.5..... | 39.3 |

| t° | Gms. $S(CH_2CH_2Cl)_2$ per 100 gms. mixture. |
|---|---|
| 16.0..... | 43.7 |
| 17.5..... | 49.4 |
| 18.3..... | 56.8 |
| 19.0 (crit. t.). | 61.4 |
| 19.0..... | 66.7 |
| 17.2..... | 76.1 |
| 14.0..... | 80.9 |
| 12.0..... | 89.6 |

| t°. | Gms. $S(CH_2CH_2Cl)_2$ per 100 gms. mixture. |
|---|---|
| 9.6..... | 84.5 |
| 9.0..... | 86.4 |
| 9.5..... | 88.4 |
| 10.0..... | 90.5 |
| 12.0..... | 95.1 |
| 13.0..... | 97.4 |
| 13.0..... | 100.0 |

The authors also give data for the mutual solubility of chlorinated « Mustard Gas » and rail road light oil.

Freezing-point data for mixtures of « Mustard Gas » and sulfur are given by Wilkinson, Neilson and Wylde, 1920.

**THIOSINAMINE** (Allyl Thio Urea) $CH_2:CHCH_2NHCSNH_2$.

Freezing-point data for mixtures of thiosinamine and antipyrine are given by Mazetti, 1926.

100 cc. $H_2O$ dissolve about 5.9 gms. $NH_2.CS.NH.C_3H_5$ at 15–20°.
100 cc. 90% alcohol dissolve about 50 gms. $NH_2.CS.NH.C_3H_5$ at 15–20°.
(Squire and Caines, 1905.)

**BUTYRALDEHYDE** n. $CH_3(CH_2)_2CHO$.

100 gms. $H_2O$ dissolve 3.6 gm. normal butyraldehyde at 20°. (Vaubel, 1899.)
" " " " 10.0 " iso butyraldehyde " " " "

**ETHYL METHYL KETONE** $CH_3.CO.C_2H_5$.

SOLUBILITY IN WATER. (Rothmund, 1898.)

By synthetic method, see Note, page 292.

| t°. | Gms. Ketone per 100 Gms. Aq. Layer. | Ketone Layer. | t°. | Gms. Ketone per 100 Gms. Aq. Layer. | Ketone Layer. |
|---|---|---|---|---|---|
| −10 | 34.5 | 89.7 | 90 | 16.1 | 84.8 |
| +10 | 26.1 | 90 | 110 | 17.7 | 80 |
| 30 | 21.9 | 89.9 | 130 | 21.8 | 71.9 |
| 50 | 17.5 | 89 | 140 | 26 | 64 |
| 70 | 16.2 | 85.7 | 151.8 (crit. temp.) | | 44.2 |

The accuracy of Rothmund's data is questioned by Marshall (1906) and the following new determinations given.

| t°. | 64.7°. | 65.5°. | 73.6°. | 91.0°. | 15°. | 73.6°. |
|---|---|---|---|---|---|---|
| Wt. % Ketone in Mixture | 18.15 | 18.08 | 18 | 18.08 | 88.2 | 85.05 |

Data for the reciprocal solubility of ethyl methyl ketone and water, containing 1.5% ethyl alcohol, are given by Bruni (1899, 1900). This system is of interest particularly on account of having both an upper and a lower critical point.

Freezing-point data for mixtures of ethylmethyl ketone and water are given by Timmermans (1911) and by Bruni, 1899, 1900.

More recent determinations of the reciprocal solubility of Ethyl methyl ketone, (Butanone) and water are:

| t° | Gms. $CH_3COC_2H_5$ per 100 gms. sat. solution in $H_2O$ | Gms. $H_2O$ per 100 gms. sat. solution in $CH_3COC_2H_5$ | Authority |
|---|---|---|---|
| 20 | 24.0 | 10.0 | (Jones, 1929.) |
| 25 (approx.) | 22.6 | 9.9 | (Park and Hofmann, 1832.) |

Approximate determinations of the Solubility of Ethyl Methyl Ketone (Butanone) in aqueous solutions of metal perchlorates show that the volume of butanone dissolved per 10 cc of cold perchlorate solutions increases from about 5 cc to more than 10 cc as the concentrations of perchlorate increases from 0.1 to 0.3 normal. (Duclaux and Durand-Gasselin, 1938.)

### Mutual Solubility of Ethyl Methyl Ketone and Glycerol
(Mc Ewen, 1923.)

The synthetic method was used. The temperatures were determined at which liquid phases separated from mixtures of known composition.

| t°. | Wt. per cent $CH_3.CO.C_2H_5$. | t°. | Wt. per cent $CH_3.CO.C_2H_5$. | t°. | Wt. per cent $CH_3.CO.C_2H_5$. |
|---|---|---|---|---|---|
| 37.5..... | 4.0 | 162.5..... | 36.17 | 161.5..... | 67.14 |
| 116.5..... | 10.21 | 163.2..... | 41.27 | 150.0..... | 74.78 |
| 128.5..... | 13.21 | 164.5..... | 53.84 | 118.5..... | 86.55 |
| 155.5..... | 26.75 | 164.5..... | 60.25 | 55.5..... | 92.14 |

Freezing-point data for mixtures of Ethyl Methyl Ketone and Acetone are given by Sapgir, 1929.

## DiETHYLENE ETHER $(CH_2OCH_2)_2$.

Freezing-point data are given for mixtures of diethylene ether and water, by Unkovskaja, 1913.

## PROPYL FORMATE $HCOOC_3H_7$.

100 cc $H_2O$ dissolve 2.1 gm. $HCOOC_3H_7$ at 22°. (Traube, 1884.)

## ETHYL ACETATE $CH_3COOC_2H_5$.

### Solubility of Ethyl Acetate in Water and Vice Versa.
(Merriman, 1913, see also Seidell, 1910.)

Results for Ethyl Acetate in Water.

| t°. | $d_{\frac{t}{4^\circ}}$ of Sat. Sol. | Gms. $CH_3COOC_2H_5$ per 100 Gms. $H_2O$. |
|---|---|---|
| 0 | 1.0034 | 11.21 |
| 5 | 1.0022 | 10.38 |
| 10 | 1.0009 | 9.67 |
| 15 | 0.9995 | 9.05 |
| 20 | 0.9979 | 8.53 |
| 25 | 0.9962 | 8.08 |
| 30 | 0.9943 | 7.71 |
| 40 | 0.9901 | 7.10 |

Results for Water in Ethyl Acetate.

| t° | $d_{\frac{t}{4^\circ}}$ of Sat. Sol. | Gms. $H_2O$ per 100 Gms. $CH_3COOC_2H_5$. |
|---|---|---|
| 0 | 0.9280 | 2.34 |
| 10 | 0.9164 | 2.68 |
| 20 | 0.9054 | 3.07 |
| 25 | 0.9002 | 3.30 |
| 30 | 0.8953 | 3.52 |
| 40 | 0.8863 | 4.08 |
| 50 | ... | 4.67 |
| 60 | ... | 5.29 |

### Solubility of Ethyl Acetate in Water. (Glasstone and Pound, 1925.)

Highly purified ethyl acetate was used. A slight excess of it was shaken with water at a temperature below that of the experiment and then placed in a thermostat. The excess of ethyl acetate then separating caused the liquid to become cloudy, but this disappeared in an hour or two. Care was always taken that the excess of ethyl acetate present was not large enough to require a correction for the amount of water dissolved by it. For analysis the saturated solution was weighed. The ethyl acetate was distilled out, hydrolyzed with standard Na OH, and estimated in the usual way.

| t°. | Gms. $CH_3COOC_2H_5$ per 100 gms. $H_2O$. | t°. | Gms. $CH_3COOC_2H_5$ per 100 gms. $H_2O$. |
|---|---|---|---|
| 0..... | 10.40 | 30..... | 7.06 |
| 10..... | 8.96 | 37..... | 6.65 |
| 20..... | 7.85 | 40..... | 6.50 |
| 25..... | 7.39 | 50..... | 6.04 |

The following results, in terms of grams $CH_3CO\,OC_2H_5$ per 100 gms. $H_2O$, are probably less accurate than the above. At 16°, 12.5 gms. (Linde, 1917, 1926); at 18°, 7.3 gms. (von Euler and Svanberg, 1917, 1926); at 20°, 6.88 gms. (approx. det. only) (Führer, 1924); at 29°.7, 7.47 gms. (von Euler and Rudberg, 1924).

## Solubility of Ethyl Acetate in Water and Vice Versa.

| t° | Gms. $CH_3COOC_2H_5$ per 100 gms. sat. sol. in $H_2O$ | Gms. $H_2O$ per 100 gms. sat. sol. in $CH_3COOC_2H_5$ | Authority |
|---|---|---|---|
| 0 | 10 | 2.26 | (Mion, 1931.) |
| 15 | 8.3 (8.864) | 2.82 | " " |
| 20 | 8.53(8.420) | 3.07 | (Jones, 1929.) |
| 25(about) | 7.9 (8.030) | 3.0 | (Park and Hofmann, 1932.) |
| 30 | 7.1 (7.692) | 3.52 | (Mion, 1931.) |
| 40 | — (7.177) | — | |
| 50 | — (6.875) | — | |

The results in parentheses are in terms of gms. $CH_3COOC_2H_5$ per 100 gms. $H_2O$, and are the averages of a large number of determinations made by the synthetic, sealed tube method, by Schlesinger and Kubasowa, 1929.

The following results for the solubility of ethyl acetate in water, in terms of molecular percent are by Kendall and Harrison, 1928.

| t° | Mol. Percent $CH_3COOC_2H_5$ in sat. sol. | t° | Mol. Percent $CH_3COOC_2H_5$ in sat. sol. |
|---|---|---|---|
| 0 | 2.08 | 30 | 1.42 |
| 10 | 1.79 | 37 | 1.34 |
| 20 | 1.58 | 40 | 1.31 |
| 25 | 1.48 | 50 | 1.21 |

These authors also give the following results for the freezing-point of aqueous solutions of ethyl acetate.

| t° | Mol. Percent $CH_3COOC_2H_5$ in solution | t° | Mol. Percent $CH_3COOC_2H_5$ in solution |
|---|---|---|---|
| -0.190 | 0.181 | 1.431 | 1.362 |
| -0.398 | 0.379 | 1.797 | 1.718 |
| -0.594 | 0.574 | 2.034 | 1.945 |
| -1.007 | 0.963 | 2.224 | 2.134 |
| -1.203 | 1.148 | | |

## ETHYL ACETATE

### Solubility of Ethyl Acetate in Aqueous Solutions.

(Glasstone and Pound, 1925; Glasstone, Dimond and Jones, 1926: Glasstone, Dimond and Harris, 1926.)

These authors have made a very careful and comprehensive study of the solubility of ethyl acetate in aqueous solutions of various salts and sugars. They give results at 25° and at 50° for aqueous solutions of Li Cl, Li Br, Li I, K Cl, K Br, K I, Na Cl, Na Br, Na I, Rb Cl, Rb Br, Rb I, Cs Cl, Cs Br, Cs I, $NH_4$ Cl, $NH_4$ Br, $NH_4$ I, dextrose, levulose, sucrose and lactose. They also give results at 25° for aqueous solutions of $Na\,NO_3$, $Pb\,(NO_3)_2$, $NH_4\,NO_3$, $CH_3\,CO\,O\,NH_4$, $K\,Cr\,O_4$, $Ca\,(NO_3)_2$, $Sn\,(NO_3)_2$, $Ba\,(NO_3)_2$, $K\,NO_3$, $Ba\,Cl_2$, $Cu\,Cl_2$, $Ni\,SO_4$, $K_2\,SO_4$, $(CO\,O\,NH_4)_2$, $Mg\,SO_4$, $Na_2\,SO_4$, $Cu\,SO_4$, $Zn\,SO_4$, $K\,Fe\,(CN)_6$, $K_3\,Fe\,(CN)_6$, $K\,Cl\,O_3$, K F and various mixtures of these salts. The results are, however, all expressed « in terms of the number of *gram molecules of water* required to dissolve one gram molecule of ethyl acetate in the presence of various molecular quantities of added sugar or salt ». The experiments were made for the purpose of explaining the salting-out effect of various compounds. It was concluded from the results that the hydration of the salt may be one of the factors responsible for the salting-out effect; this effect may, however, be due to some other fundamental property of salt ions or molecules. The salting-out power of a mixture is, in general, equal to the sum of the salting-out powers of the constituents, provided allowance is made for the electrical interaction of the ions. The salting-out effect cannot be utilized for the detection of complex ion formation.

In spite of the undoubted interest of these results as quantitative solubility measurements, their recalculation to the more usual terms of expression would involve a considerable effort. Furthermore, since they are published in one of the most easily accessible journals there appears less need for their reproduction in the present compilation.

### Solubility of Ethyl Acetate in Aqueous Solutions of :

(von Euler and Rudberg, 1924.)

Lithium Nitrate at 29°.7.

| Gm. mols. per liter. | |
|---|---|
| $LiNO_3$. | $CH_3\,COO\,C_2\,H_5$. |
| 0.00 | 0.791 |
| 0.0362 | 0.787 |
| 0.0723 | 0.784 |
| 0.1810 | 0.764 |

Potassium Nitrate at 30°.1.

| Gm. mols. per liter. | |
|---|---|
| $KNO_3$. | $CH_3\,COO\,C_2\,H_5$. |
| 0.000 | 0.779 |
| 0.100 | 0.756 |
| 0.250 | 0.734 |

### Solubility of Ethyl Acetate at 16°-16°.5 in Aqueous Solutions of :

(Linde 1917. 1926.)

Sodium Chloride.

| Mols. Na Cl. per liter. | Gms $CH_3\,COO\,C_2\,H_5$ per 100 cc. solvent. |
|---|---|
| 0.125 | 11.5 (12.7) |
| 0.25 | 10.75 (11.6) |
| 0.50 | 9.9 (10.8) |
| 0.75 | 9.0 (10.0) |
| 1.00 | 8.4 (9.2) |

Sodium Nitrate.

| Mols. $NaNO_3$ per liter. | Gms $CH_3\,COO\,C_2\,H_5$ per 100 cc. solvent. |
|---|---|
| 0.00 | 12.5 |
| 0.25 | 12.0 |
| 0.50 | 11.8 (13.5) |
| 0.75 | 11.5 |
| 1.00 | 11.4 (13.3) |

The results in parentheses show the grams of $CH_3\,CO\,O\,C_2\,H_5$ per 100 cc. of salt solution made with 0.95 normal $C_2\,H_5\,OH$ instead of water.

100 cc. sat. solution of ethyl acetate in aqueous 1.0 normal aniline nitrate contain 12.5 gms $CH_3\,CO\,O\,C_2\,H_5$ at 18°. (von Euler and Svanberg, 1917, 1926.)

## Solubility in Water and in Aqueous Salt Solutions at 28°.

(Euler — Z. physik. Chem. 31, 365, '99; 49, 306, '04.)

| Solvent. | Conc. of Salt Solution. Normality. | Conc. of Salt Solution. Gms. per Liter. | $CH_3COOC_2H_5$ per Liter. Gram Mols. | $CH_3COOC_2H_5$ per Liter. Grams. |
|---|---|---|---|---|
| Water | 0 | 0 | 0.825 | 75.02 |
| $KNO_3$ | ½ | 50.59 | 0.77 | 67.81 |
| " | 1 | 101.19 | 0.72 | 63.40 |
| " | 2 | 202.38 | 0.625 | 55.04 |
| KCl | ¼ | 18.4 | 0.747 | 65.79 |
| " | ½ | 36.8 | 0.685 | 65.33 |
| " | 1 | 73.6 | 0.575 | 50.64 |
| " | 2 | 147.2 | 0.41 | 36.11 |
| NaCl | ¼ | 14.62 | 0.745 | 65.61 |
| " | ½ | 29.25 | 0.677 | 59.62 |
| " | 1 | 58.5 | 0.545 | 47.99 |
| " | 2 | 117.0 | 0.315 | 27.74 |
| NaCl (at 18°) | ¼ | 14.62 | 0.76 | 67.0 |
| " " | ½ | 29.25 | 0.67 | 59.0 |
| " " | 1 | 58.5 | 0.51 | 45.0 |
| $Na_2SO_4$ | 1 | 71.08 | 0.465 | 40.96 |
| " (at 18°) | ½ | 35.54 | 0.61 | 54.0 |
| " " | 1 | 71.08 | 0.42 | 37.0 |
| $MgSO_4$ | ¼ | 16.30 | 0.733 | 64.55 |
| " | ½ | 32.6 | 0.655 | 57.68 |
| " | 1 | 65.21 | 0.505 | 44.47 |
| $ZnSO_4$ | ¼ | 20.18 | 0.733 | 64.55 |
| " | ½ | 40.36 | 0.653 | 57.50 |
| " | 1 | 80.73 | 0.500 | 44.03 |

Additional data for the influence of salts upon the solubility of ethyl acetate in water are given by Lunden, 1913.

## Solubility of Ethyl Acetate in Aqueous Salt Solutions.

(Schlesniger and Kubasowa, 1929.)

The determinations were made by the synthetic, sealed tube method. The results were plotted and average values obtained from the curves.

| Composition of aqueous solvent Salt | Normality | Gms. $CH_3COOC_2H_5$ dissolved per 100 gms. sat. solution at: 15° | 20° | 25° | 30° | 35° | 40° | 50° |
|---|---|---|---|---|---|---|---|---|
| NaCl | 0.10 | 8.672 | 8.084 | 7.646 | 7.302 | 7.016 | 6.806 | 6.457 |
| " | 0.25 | 8.159 | 7.607 | 7.171 | 6.825 | 6.543 | 6.297 | 5.819 |
| " | 0.50 | 7.400 | 6.872 | 6.553 | 6.269 | 6.017 | 5.800 | 5.466 |
| " | 1.00 | 6.002 | 5.656 | 5.349 | 5.083 | 4.858 | 4.672 | 4.422 |
| KBr | 0.10 | 8.926 | 8.372 | 7.947 | 7.573 | 7.250 | 6.979 | 6.589 |
| " | 0.25 | 8.528 | 8.008 | 7.557 | 7.232 | 6.859 | 6.612 | 6.324 |
| " | 0.50 | 7.936 | 7.437 | 7.010 | 6.656 | 6.373 | 6.163 | 5.958 |
| " | 1.00 | 7.071 | 6.659 | 6.293 | 5.972 | 5.698 | 5.469 | 5.151 |
| KI | 0.10 | 8.810 | 8.444 | 8.042 | 7.699 | 7.377 | 7.114 | 6.727 |
| " | 0.25 | 8.778 | 8.303 | 7.895 | 7.531 | 7.233 | 6.995 | 6.695 |
| " | 0.50 | 8.820 | 8.213 | 7.817 | 7.416 | 7.082 | 6.816 | 6.486 |

## Solubility of Ethyl Acetate in Aqueous Solutions of Sodium Salts of Organic Acids at 18°.

(Traube, Schöning and Weber, 1927.)

| Composition of aqueous solvents Salt | Normality | cc $CH_3COOC_2H_5$ per 6cc of the aqueous solvent |
|---|---|---|
| Sodium butyrate | Almost saturated | 0.5 |
| Sodium benzoate | 0.0 | 0.45 |
| " " | saturated | 1.3 |
| Sodium salicylate | 1.0 | 1.3 |
| " " | 1.5 | 1.8 |
| " " | saturated | ∞ |

100 gms. aqueous 0.4 normal Sodium Oleate Solution (= 10.8 gm. Na oleate per 100 gms. solution) dissolve 18.7 gms. $CH_3COOC_2H_5$ at 20°. At the same temperature 100 gms. $H_2O$ dissolve 8.6 gms. $CH_3COOC_2H_5$. (Smith, 1932.)

### Solubility of Ethyl Acetate in Aqueous Solutions of Ethyl Alcohol at 25°.
(Seidell, 1910.)

| Wt. % $C_2H_5OH$ in Solvent. | $d_{25}$ of Sat. Sol. | cc. $CH_3COOC_2H_5$ per 100 cc. Solvent. | Gms. $CH_3COOC_2H_5$ per 100 Gms. Solvent. |
|---|---|---|---|
| 0 | 0.999 | 10 | 8.6 |
| 5 | 0.993 | 10.5 | 9.5 |
| 10 | 0.986 | 12 | 10.9 |
| 15 | 0.974 | 15 | 13.3 |
| 20 | 0.960 | 27 | 19.6 |
| 25 | 0.945 | 44 | 37.0 |
| 30 | 0.931 | 70 | 66.7 |
| 35 | 0.918 | 125 | 132.5 |
| 40 | ... | ∞ | ∞ |

A second phase separates from a mixture of 3.0 cc of $C_2H_5OH$ + 3.0 cc of $CH_3COOC_2H_5$ upon the addition of 6.0 cc of $H_2O$ at room temperature.
(Pfeiffer, 1892.)

### Equilibrium in the System Ethyl Acetate, Furfural and Water at 25°.
(Lloyd, Thompson and Ferguson, 1937.)

The binodal curve was determined by the titration method. Tie lines were located by weighing the two layers separating from a mixture of known composition and analysing one of these for furfural, by the colorimetric method.

| Gms. per 100 gms. homogeneous mixture | | | Gms. per 100 gms. homogeneous mixture | | |
|---|---|---|---|---|---|
| $H_2O$ | $C_4H_3OCH_3$ | $CH_3COOC_2H_5$ | $H_2O$ | $C_4H_3OCH_3$ | $CH_3COOC_2H_5$ |
| 92.44 | 0.0 | 7.56 | 4.9 | 74.7 | 10.4 |
| 91.7 | 1.7 | 6.6 | 4.6 | 71.9 | 23.5 |
| 91.2 | 3.9 | 4.9 | 4.8 | 60.7 | 34.5 |
| 91.5 | 5.3 | 3.2 | 4.4 | 51.4 | 44.2 |
| 91.1 | 6.5 | 2.4 | 4.1 | 33.3 | 62.6 |
| 91.3 | 6.8 | 1.9 | 4.2 | 21.9 | 73.9 |
| 92.0 | 7.4 | 0.6 | 4.3 | 15.8 | 79.9 |
| 92.3 | 7.7 | 0.0 | 3.4 | 6.9 | 89.7 |
| 5.3 | 94.7 | 0.0 | 3.5 | 3.3 | 93.2 |
| 5.1 | 86.3 | 8.6 | 3.24 | 0.0 | 94.76 |

The percentage of furfural in three adjoining layers was found to be:

| | | | |
|---|---|---|---|
| Layer I | 3.8 | 5.0 | 6.7 |
| Layer II | 31.9 | 70.5 | 90.1 |

### Freezing-points of Mixtures of Ethyl Acetate and Ethyl Alcohol.
(Sapgir, 1929.)

| t° | Gms. $CH_3COOC_2H_5$ per 100 gms. mixture | t° | Gms. $CH_3COOC_2H_5$ per 100 gms. mixture |
|---|---|---|---|
| | 100 | - 96.5 | 41.5 |
| -83.6 | 88.6 | -110.0 | 28.5 |
| -87 | 71.6 | -115.5 | 12.4 |
| -90 | 53.2 | -114.1 | 0.0 |
| -92 | | | |

Freezing-point data are also given for mixtures of Ethyl Acetate and:

Tri chloro Acetic Acid (1)
Aniline (2)
Carbon Disulfide (3)
Carbon Tetrachloride(4)
Methyl formate (3)
Nitrobenzene (5)

(1) Kendall and Booge, 1916; (2) Wroczynski and Guye, 1910; (3) Sapgir, 1929; (4) Wyatt, 1929; (5) Timmermans, 1931.)

**METHYL PROPIONATE** $C_2H_5COOCH_3$.

RECIPROCAL SOLUBILITY OF METHYL PROPIONATE AND WATER.
(Kendall and Harrison, 1928.)

| $t^o$ | Mol. Percent $C_2H_5COOCH_3$ in sat. solution | $t^o$ | Mol. Percent $C_2H_5COOCH_3$ in sat. solution |
|---|---|---|---|
| - 2.1 | 1.95 | 20.0 | 1.47 |
| + 1.0 | 1.80 | 27.1 | 1.40 |
| 11.5 | 1.58 | 32.5 | 1.38 |
| 14.9 | 1.53 | 42.7 | 1.33 |

The authors also give the following freezing points of aqueous solutions of methyl propionate:

| $t^o$ | Mol. Percent $C_2H_5COOCH_3$ in solution | $t^o$ | Mol Percent $C_2H_5COOCH_3$ in solution |
|---|---|---|---|
| -0.059 | 0.065 | 0.776 | 0.752 |
| -0.141 | 0.151 | 0.896 | 0.862 |
| -0.318 | 0.339 | 0.978 | 1.035 |
| -0.425 | 0.451 | 1.415 | 1.364 |
| -0.510 | 0.524 | 1.828 | 1.748 |
| | | 2.037 | 1.948 |

**n PROPYL FORMATE** $HCOOC_3H_7$.

RECIPROCAL SOLUBILITY OF n PROPYL FORMATE AND WATER.
(Kendall and Harrison, 1928.)

| $t^o$ | Mol. Percent $HCOOC_3H_7$ in sat. sol. | $t^o$ | Mol. Percent $HCOOC_3H_7$ in sat. sol. |
|---|---|---|---|
| - 1.0 | 0.760 | 20.0 | 0.589 |
| + 4.0 | 0.695 | 30.0 | 0.569 |
| 6.0 | 0.670 | 34.0 | 0.555 |
| 12.5 | 0.620 | 45.0 | 0.535 |

The authors also give the following freezing-points of aqueous solutions of n Propyl Formate.

| $t^o$ | Mol. Percent $HCOOC_3H_7$ in solution | $t^o$ | Mol. Percent $HCOOC_3H_7$ in solution |
|---|---|---|---|
| -0.071 | 0.077 | -0.575 | 0.567 |
| -0.082 | 0.091 | -0.620 | 0.600 |
| -0.236 | 0.248 | -0.721 | 0.680 |
| -0.315 | 0.325 | -0.821 | 0.750 |

**n BUTYL BROMIDE** $CH_3(CH_2)_2CH_2Br$.

100 gms. $H_2O$ dissolve 0.0608 gm. $C_4H_9Br$ at 30°. (Gross and Saylor, 1931.)

**BUTYRIC ACIDS** (normal) $CH_3(CH_2)_2COOH$; (iso) $(CH_3)_2CH.COOH$.

SOLUBILITY OF NORMAL BUTYRIC ACID IN WATER, DETERMINED BY THE FREEZING-POINT METHOD. (Faucon, 1909, 1910.)

| t° of Congealing. | Gms. Acid per 100 Gms. Mixture. | t° of Congealing. | Gms. Acid per 100 Gms. Mixture. | t° of Congealing. | Gms. Acid per 100 Gms. Mixture. |
|---|---|---|---|---|---|
| 0 | 0 | − 3.57 | 67.38 | −13.40 | 87.62 Eutec. |
| −1.08 | 5.12 | − 5.20 | 75 | −12.40 | 90.08 |
| −2.70 | 12.75 | − 6.80 | 80 | −10 | 95.92 |
| −2.96 | 25.32 | − 8.61 | 84 | − 8 | 98.60 |
| −3.07 | 50.60 | −10.25 | 85.41 | − 5.40 | 99.15 |
| −3.14 | 59.72 | −12.54 | 86.54 | − 3.12 | 100 |

Higher values for the temperature of congealing of the above mixtures are given by Ballo (1910). For additional data see also Timmermans (1907) and Tsakalotos (1914). Data for the miscibility of normal butyric acid and water are also given by Faucon. The curve is entirely in the metastable region. The mixtures are either opalescent or completely homogeneous and never form two distinct layers, even with the application of centrifugal force. The results are as follows:

| | | | | | | |
|---|---|---|---|---|---|---|
| t° of opalescence | −5.2 | −4.2 | −4 | −3.8 crit. t. | −4.5 | −7 |
| Gms. acid per 100 gms. mixture | 25 | 30 | 35 | 40 | 50 | 58.2 |

SOLUBILITY OF ISOBUTYRIC ACID IN WATER, DETERMINED BY THE FREEZING-POINT METHOD. (Faucon, 1910.)

The congealing temperatures for mixtures containing up to 60 grams isobutyric acid per 100 gms. coincide with the results given in the above table for normal butyric acid and water. For higher concentrations the following results were obtained.

| | | | | | |
|---|---|---|---|---|---|
| t° of congealing | −3.09 | −3.35 | −3.61 | −12.5 | −80 |
| Gms. acid per 100 gms. mixture | 70.10 | 82.08 | 86.44 | 97.21 | 100 |

MISCIBILITY OF ISOBUTYRIC ACID AND WATER, DETERMINED BY THE "SYNTHETIC METHOD." (Smirnoff, 1907.)

| t°. | Gms. Acid per 100 Gms.: Upper Layer. | Lower Layer. |
|---|---|---|
| 10.05 | 69.08 | 17.82 |
| 12 | 67.1 | 18.3 |
| 14 | 64.9 | 19.1 |
| 16 | 62.3 | 20 |
| 18 | 59.2 | 21.1 |
| 20 | 55.4 | 22.8 |
| 22 | 49 | 25.8 |
| 22.5 | 46 | 27 |
| 23 | 41 | 29 |
| 23.3 crit. t. | 34.7 | |

Determinations varying more or less from the above are given by Rothmund (1898), Friedlander (1901) and Faucon (1910). The discrepancies are shown by Smirnoff to be due to the effect of variations in purity of the isobutyric acid upon the position of the curve. Smirnoff fractionated the purest obtainable acid and determined the miscibility curve for each fraction. The above results were obtained with fraction 4 of boiling point 154°–155°, twice refractionated.

An extensive series of determinations are given by Smirnoff of the effect of various percentages of different salts upon the temperature of immiscibility of aqueous 16.46% isobutyric acid solution.

A later determination of the reciprocal solubility of iso butyric acid and water at 20°, reported by Jones, 1929, agrees with the above result of Smirnoff, 1907.

Other determinations of the critical solution temperatures of mixtures of normal and of iso butyric acids and water are as follows:

| Mixture | c.s.t. | Gms. $C_4H_8O_2$ per 100 gms. sat. sol. | Authority |
|---|---|---|---|
| Normal acid + $H_2O$ | −1.1 | 26 | Howard and Patterson, 1926. |
| " " + " | −4.1 | — | Timmermans & Hennaut-Roland, 1932. |
| " " + " | −1.6 | 33 | Patterson, 1938. |
| iso " + " | +17.7 | 30 | Howard and Patterson, 1926. |
| " " + " | 26.2 | — | Timmermans and Delcourt, 1934. |
| " " + " | 21.9 | 32 | Patterson, 1938. |

Results showing that the critical solution temperatures of normal and of iso butyric acids and water are raised respectively 23.6° and 19.5° by replacement of ordinary with heavy water (Deuterium Oxide) are given by Patterson, 1938. Timmermans and Poppe, 1935a, report an elevation of 23.45° in the case of normal butyric acid and heavy instead of ordinary water. A method for estimating various percentages of deuterium oxide in ordinary water, based upon the degree of elevation of the critical solution temperatures of normal and of iso butyric acids, is proposed by Patterson, 1938.

Results showing the elevation of the critical solution temperature of iso butyric acid and water caused by the presence of hydrochloric acid and of various salts and their mixtures are given by Carter and Megson, 1927.

### The Mutual Solubility of Iso Butyric Acid and Water at High Pressures.
(Timmermans, 1922.)

The following determinations of the critical temperature of solution at high pressures are given.

The constants of the iso butyric acid were, b. pt. = 154°.35, f. pt. −4°.7, $d_4^{\circ} = 0.96819$.

| Pressure in kilograms. | Critical temp. of solution. | Pressure in kilograms. | Critical temp. of solution. |
|---|---|---|---|
| 1 | 26.4 | 300 | 9.40 |
| 50 | 23 76 | 475 | 0.0 |
| 100 | 21.14 | 525 | −2.6 |
| 170 | 17.34 | (ord. pressure) | −3.0 (cryst. pt. of triphase system) |

### Distribution of Normal Butyric Acid Between :

Water and Chloroform at 25°. (Smith, 1921-1922.)

| Millimols. $CH_3(CH_2)_2COOH$ per liter of $H_2O$ layer ($C_1$). | Millimols. $CH_3(CH_2)_2COOH$ per liter of $CHCl_3$ layer ($C_2$). | $\frac{C_2}{C_1}$. |
|---|---|---|
| 1.040 | 0.488 | 0.470 |
| 1.169 | 0.574 | 0.491 |
| 1.402 | 0.710 | 0.506 |
| 1.680 | 0.866 | 0.516 |
| 2.290 | 1.252 | 0.546 |
| 3 930 | 2.190 | 0.557 |

Water and Ethyl Ether at 25°. (Smith, 1921-1922.)

| Millimols. $CH_3(CH_2)_2COOH$ per liter in $H_2O$ layer ($C_1$). | Millimols. $CH_3(CH_2)_2COOH$ per liter in $(C_2H_5)_2O$ layer ($C_2$). | $\frac{C_2}{C_1}$. |
|---|---|---|
| 0.335 | 1.40 | 4.18 |
| 0.59 | 2.65 | 4.50 |
| 1.60 | 5.02 | 4.73 |
| 1.80 | 9.20 | 5.12 |
| 2.64 | 14.04 | 5.32 |

Water and Ethyl Ether at 21°. (Behrens, 1926.)

| Concentration in $H_2O$ layer ($C_1$). | Concentration in $(C_2H_5)_2O$ layer ($C_2$). | $\frac{C_2}{C_1}$. |
|---|---|---|
| 0.01214 | 0.0744 | 6.13 |
| 0.0181 | 0.1136 | 6 28 |
| 0.0228 | 0.1469(12°) | 6.44 |
| 0.0264 | 0.1707 | 6.46 |
| 0.0407 | 0.2763 | 6.79 |

### Distribution of Normal Butyric Acid at 25° Between : (Smith, 1921-1922.)

Water and Xylene.

| Millimols. $CH_3(CH_2)_2COOH$ per liter of | | |
|---|---|---|
| $H_2O$ layer ($C_1$). | $C_6H_4(CH_3)_2$ layer ($C_2$). | $\frac{C_2}{C_1}$. |
| 4.500 | 0.700 | 0.156 |
| 6.475 | 1.025 | 0.158 |
| 8.20 | 1.30 | 0.159 |

Acetone and Glycerol.

| Millimols. $CH_3(CH_2)_2COOH$ per liter of | | |
|---|---|---|
| Glycerol layer (G). | Acetone layer (A). | $\frac{A}{G}$. |
| 0.275 | 3.45 | 12.5 |
| 0.50 | 6.4375 | 12.8 |
| 1.15 | 14.60 | 12.7 |
| 2.10 | 26 65 | 18.7 |

### Distribution of Butyric Acid at 25° Between Water and Cotton Seed Oil.

(Gordon and Reid, 1922.)

| Gms. Butyric Acid per 100 gms. | |
|---|---|
| $H_2O$ layer. | Oil layer. |
| 2.7 | 1.11 |
| 5.0 | 2.85 |
| 9.2 | 6.96 |
| 14.0 | 10.45 |
| 30.5 | 20.8 |
| 41.3 | 22.8 |

### Distribution of Iso Butyric Acid at 25° Between : (Smith, 1921-1922.)

Water and Benzene.

| Millimols. $(CH_3)_2CHCOOH$ per liter of | | |
|---|---|---|
| $H_2O$ layer ($C_1$). | $C_6H_6$ layer ($C_2$). | $\frac{C_2}{C_1}$. |
| 2.55 | 0.410 | 0.170 |
| 3.75 | 0.7125 | 0.190 |
| 9.60 | 2.20 | 0.230 |
| 18.90 | 5.0 | 0.264 |

Water and Carbon Tetrachloride.

| Millimols. $(CH_3)_2CHCOOH$ per liter of | | |
|---|---|---|
| $H_2O$ layer ($C_1$). | $CCl_4$ layer ($C_2$). | $\frac{C_2}{C_1}$. |
| 4.775 | 0.305 | 0.0639 |
| 7.10 | 0.595 | 0.0838 |
| 9.25 | 1.05 | 0.1135 |
| 13.80 | 1.725 | 0.125 |
| 17.50 | 2.70 | 0.154 |

Water and Chloroform.

| Millimols. $(CH_3)_2CHCOOH$ per liter of | | |
|---|---|---|
| $H_2O$ layer ($C_1$). | $CHCl_3$ layer ($C_2$). | $\frac{C_2}{C_1}$. |
| 1.025 | 0.350 | 0.342 |
| 2.100 | 0.750 | 0.357 |
| 3.190 | 1.275 | 0.400 |
| 5.450 | 2.350 | 0.431 |

Note. — In the series of papers by Smith, 1921-1922, the results for the distribution of butyric acids are given under « *n* butyric acid » and « *sec.* butyric acid. » In the absence of any description or constants of either of the compounds it is assumed that *Iso* butyric acid was employed in all cases referred to under « *sec.* butyric acid ».

### Distribution of Iso Butyric Acid at 25° Between : (Smith, 1921-1922.)

Water and Ethyl Ether.

| Millimols. $(CH_3)_2CHCOOH$ per liter of | | |
|---|---|---|
| $H_2O$ layer ($C_1$). | $(C_2H_5)_2O$ layer ($C_2$). | $\frac{C_2}{C_1}$. |
| 0.29375 | 0.85625 | 2.92 |
| 0.500 | 1.6125 | 3.22 |
| 0.975 | 3.225 | 3.30 |
| 1.625 | 5.575 | 3.43 |
| 2.6 | 8.4 | 3.23 |

Acetone and Glycerol.

| Millimols. $(CH_3)_2CHCOOH$ per liter of | | |
|---|---|---|
| Glycerol layer (G). | Acetone layer (A). | $\frac{A}{G}$. |
| 0.350 | 3.40 | 9.72 |
| 0.375 | 3.375 | 9.00 |
| 0.625 | 6.825 | 9.90 |
| 0.65 | 6.80 | 10.45 |
| 1.30 | 11.85 | 9.14 |
| 2.20 | 20.20 | 9.20 |

### Distribution of Iso Butyric Acid at 25° Between : (Smith, 1921-1922.)

Water and Toluene.

| Millimols. $(CH_3)_2CHCOOH$ per liter of | | |
|---|---|---|
| $H_2O$ layer ($C_1$). | $C_6H_5CH_3$ layer ($C_2$). | $\frac{C_2}{C_1}$. |
| 1.975 | 0.2025 | 0.1025 |
| 3.60 | 0.50 | 0.139 |
| 8.90 | 1.65 | 0.185 |
| 15.70 | 5.50 | 0.350 |

Water and Xylene.

| Millimols. $(CH_3)_2CHCOOH$ per liter of | | |
|---|---|---|
| $H_2O$ layer ($C_1$). | $C_6H_4(CH_3)_2$ layer ($C_2$). | $\frac{C_2}{C_1}$. |
| 3.65 | 0.574 | 0.157 |
| 9.575 | 1.625 | 0.17 |
| 18.35 | 3.50 | 0.19 |

### Distribution of Normal Butyric Acid at 25° Between Water and:

(Smith and White, 1929.)

| Chloroform | | Benzene | | Toluene | |
|---|---|---|---|---|---|
| Gm. Mols. $C_4H_8O_2$ per liter | | Gm. Mols. $C_4H_8O_2$ per liter | | Gm. Mols. $C_4H_8O_2$ per liter | |
| $H_2O$ layer | $CHCl_3$ layer | $H_2O$ layer | $C_6H_6$ layer | $H_2O$ layer | $C_6H_5CH_3$ layer |
| 0.00178 | 0.000924 | 0.0044 | 0.0011 | 0.00457 | 0.000813 |
| 0.00367 | 0.00213 | 0.00735 | 0.00208 | 0.00781 | 0.00162 |
| 0.00572 | 0.00348 | 0.01565 | 0.00560 | 0.01651 | 0.00474 |
| 0.01435 | 0.01258 | 0.02403 | 0.01078 | 0.02541 | 0.00940 |
| 0.02200 | 0.02500 | 0.03921 | 0.02340 | 0.04143 | 0.02117 |
| 0.03555 | 0.05505 | 0.06380 | 0.05410 | 0.06775 | 0.05115 |
| 0.05898 | 0.1269 | 0.1171 | 0.1597 | 0.1249 | 0.1519 |
| 0.09665 | 0.2982 | 0.1661 | 0.3039 | 0.1794 | 0.2906 |
| 0.1260 | 0.4710 | 0.2163 | 0.4897 | 0.2341 | 0.4719 |

### Distribution of Iso Butyric Acid at 25° Between Water and:

(Smith and White, 1929.)

| Chloroform | | Benzene | | Toluene | |
|---|---|---|---|---|---|
| Gm. Mols. $C_4H_8O_2$ per liter | | Gm. Mols. $C_4H_8O_2$ per liter | | Gm. Mols. $C_4H_8O_2$ per liter | |
| $H_2O$ layer | $CHCl_3$ layer | $H_2O$ layer | $C_6H_6$ layer | $H_2O$ layer | $C_6H_5CH_3$ layer |
| 0.00333 | 0.00198 | 0.00774 | 0.00213 | 0.00818 | 0.00173 |
| 0.00608 | 0.00426 | 0.00995 | 0.00302 | 0.01744 | 0.00539 |
| 0.01111 | 0.00959 | 0.0164 | 0.00639 | 0.02278 | 0.00850 |
| 0.01838 | 0.02042 | 0.0215 | 0.00978 | 0.03880 | 0.02082 |
| 0.02623 | 0.03680 | 0.0364 | 0.0232 | 0.05308 | 0.03662 |
| 0.04101 | 0.07969 | 0.0493 | 0.0404 | 0.09440 | 0.1088 |
| 0.06315 | 0.1721 | 0.0877 | 0.1156 | 0.09440 | 0.1088 |
| 0.09380 | 0.3541 | 0.1470 | 0.3130 | 0.1609 | 0.3001 |
| 0.11280 | 0.4952 | 0.1906 | 0.5014 | 0.2072 | 0.4848 |

### Distribution of Butyric Acid between Water and Benzene at 13°–15°

(Georgievics, 1913.)

| Gms. Butyric Acid Used. | Gms. Acid Found per: | |
|---|---|---|
| | 150 cc. Benzene Layer. | 25 cc. $H_2O$ Layer. |
| 2.0044 | 1.7643 | 0.2401 |
| 2.9968 | 2.6965 | 0.3003 |
| 3.5028 | 3.1740 | 0.3288 |
| 4.0088 | 3.6544 | 0.3544 |
| 4.5342 | 4.1521 | 0.3821 |

The distribution ratio of normal butyric acid between water and benzene at room temperature was found by King and Narracott (1909), to be 1 to 0.7585, and for isobutyric acid, the ratio was 1 to 0.810.

One determination of the distribution of butyric acid between sat. aqueous $CaCl_2$ solution and kerosene gave 7.2 gms. acid per 100 gms. aqueous layer and 92.8 gms. per 100 gms. kerosene layer at ord. temp. (Crowell, 1918.)

### Distribution of Normal Butyric Acid Between Water and Benzene at 20°.

(Angelescu and Dutchlevici, 1932.)

| Gms. $C_4H_8O_2$ per 100 cc | | $\frac{1}{2}$ | Gms. $C_4H_8O_2$ per 100 cc | | $\frac{1}{2}$ |
|---|---|---|---|---|---|
| $H_2O$ layer(1) | $C_6H_6$ layer(2) | | $H_2O$ layer(1) | $C_6H_6$ layer(2) | |
| 2.39 | 6.49 | 0.368 | 4.96 | 21.82 | 0.227 |
| 3.10 | 10.12 | 0.306 | 5.58 | 26.63 | 0.210 |
| 3.57 | 13.20 | 0.270 | 6.39 | 32.61 | 0.196 |
| 4.08 | 16.17 | 0.252 | | | |

## Distribution of Normal Butyric Acid at 25° Between Water and Benzene.

(Brown and Bury, 1923.)

| Normality of $CH_3(CH_2)_2COOH$ in $H_2O$ layer. | Normality of $CH_3(CH_2)_2COOH$ in $C_6H_6$ layer. | Normality of $CH_3(CH_2)_2COOH$ in $H_2O$ layer. | Normality of $CH_3(CH_2)_2COOH$ in $C_6H_6$ layer. | Normality of $CH_3(CH_2)_2COOH$ in $H_2O$ layer. | Normality of $CH_3(CH_2)_2COOH$ in $C_6H_6$ layer. |
|---|---|---|---|---|---|
| 0.0421 | 0.0234 | 0.1617 | 0.257 | 0.423 | 1.116 |
| 0.0635 | 0.0525 | 0.1844 | 0.320 | 0.702 | 2.344 |
| 0.1045 | 0.1213 | 0.245 | 0.522 | 0.938 | 2.819 |
| 0.1363 | 0.1941 | 0 281 | 0.657 | 1.369 | 4.015 |

## Distribution of Normal Butyric Acid Between Water and Benzene.

(Bektourov, 1939a.)

| Results at 0°: Gm. Mols. $C_4H_8O_2$ per liter, $H_2O$ layer(1) | Results at 0°: Gm. Mols. $C_4H_8O_2$ per liter, $C_6H_6$ layer(2) | Results at 0°: $\frac{1}{2}$ | Results at 25°: Gm. Mols. $C_4H_8O_2$ per liter, $H_2O$ layer(1) | Results at 25°: Gm. Mols. $C_4H_8O_2$ per liter, $C_6H_6$ layer(2) | Results at 25°: $\frac{1}{2}$ | Results at 60°: Gm. Mols. $C_4H_8O_2$ per liter, $H_2O$ layer(1) | Results at 60°: Gm. Mols. $C_4H_8O_2$ per liter, $C_6H_6$ layer(2) | Results at 60°: $\frac{1}{2}$ |
|---|---|---|---|---|---|---|---|---|
| 0.0227 | 0.00757 | 2.99 | 0.0245 | 0.0156 | 1.57 | 0.0379 | 0.0279 | 1.360 |
| 0.0445 | 0.0227 | 1.96 | 0.0557 | 0.0390 | 1.43 | 0.0769 | 0.0936 | 0.835 |
| 0.0776 | 0.0587 | 1.32 | 0.0656 | 0.0545 | 1.20 | 0.1003 | 0.1449 | 0.692 |
| 0.1060 | 0.1041 | 1.02 | 0.1104 | 0.1412 | 0.782 | 0.1758 | 0.3567 | 0.493 |
| 0.1516 | 0.2181 | 0.727 | 0.1561 | 0.2899 | 0.539 | 0.2451 | 0.6686 | 0.367 |
| 0.2933 | 0.6624 | 0.443 | 0.2602 | 0.6913 | 0.376 | 0.3791 | 1.3826 | 0.274 |
| 0.4022 | 1.2870 | 0.313 | 0.3902 | 1.3937 | 0.280 | 0.4906 | 2.1185 | 0.232 |
| 0.5798 | 2.3749 | 0.244 | 0.5129 | 2.1631 | 0.237 | 0.6021 | 2.8098 | 0.214 |
| 0.7470 | 3.6460 | 0.208 | 0.7136 | 3.7018 | 0.193 | 0.7916 | 4.1143 | 0.192 |
| 0.9366 | 4.8614 | 0.193 | 1.0592 | 6.2440 | 0.170 | 1.0035 | 5.5750 | 0.198 |
| 1.1707 | 6.7346 | 0.174 | 1.1261 | 6.6454 | 0.169 | 1.3116 | 6.4447 | 0.204 |

Similar results for normal butyric acid are also given for 40°.

## Distribution of Iso Butyric Acid Between Water and Benzene.

(Bektourow, 1939a.)

| Results at 0°: Gm. Mols. $C_4H_8O_2$ per liter, $H_2O$ layer(1) | Results at 0°: Gm. Mols. $C_4H_8O_2$ per liter, $C_6H_6$ layer(2) | Results at 0°: $\frac{1}{2}$ | Results at 60°: Gm. Mols. $C_4H_8O_2$ per liter, $H_2O$ layer(1) | Results at 60°: Gm. Mols. $C_4H_8O_2$ per liter, $C_6H_6$ layer(2) | Results at 60°: $\frac{1}{2}$ |
|---|---|---|---|---|---|
| 0.2948 | 0.9380 | 0.314 | 0.0290 | 0.0268 | 1.084 |
| 0.3015 | 1.0921 | 0.276 | 0.0670 | 0.0938 | 0.714 |
| 0.4422 | 2.1306 | 0.208 | 0.0938 | 0.1675 | 0.560 |
| 0.5494 | 2.8140 | 0.195 | 0.1407 | 0.2881 | 0.488 |
| 0.6030 | 3.5376 | 0.170 | 0.2814 | 1.0988 | 0.256 |
| 0.7370 | 4.5560 | 0.162 | 0.5762 | 3.2026 | 0.180 |
| 1.0720 | 6.6464 | 0.161 | 0.7504 | 4.5962 | 0.163 |
| 1.3400 | 7.3700 | 0.182 | 0.9916 | 5.7754 | 0.172 |

## BUTYRIC ACID

### Distribution of Normal Butyric Acid at 25° Between Water and:

(Kolossowsky, Kulikow and Bekturow, 1934; 1935.)

| Carbon Tetrachloride | | | Nitro Benzene | | | Amyl Alcohol | | |
|---|---|---|---|---|---|---|---|---|
| Gm. Mol. $C_4H_8O_2$ per liter | | $\frac{1}{2}$ | Gm. Mol. $C_4H_8O_2$ per liter | | $\frac{1}{2}$ | Gm. Mol. $C_4H_8O_2$ per liter | | $\frac{1}{2}$ |
| $H_2O$ layer(1) | $CCl_4$ layer(2) | | $H_2O$ layer(1) | $C_6H_5NO_2$ layer(2) | | $H_2O$ layer(1) | 1 $C_5H_{11}OH$ layer (2) | |
| 0.0152 | 0.0027 | 5.70 | 0.010 | 0.004 | 2.5 | 0.0023 | 0.0233 | 0.100 |
| 0.0328 | 0.0096 | 3.40 | 0.020 | 0.010 | 2.0 | 0.0046 | 0.0459 | 0.100 |
| 0.1285 | 0.0727 | 1.77 | 0.054 | 0.033 | 1.60 | 0.0060 | 0.0589 | 0.102 |
| 0.2040 | 0.1797 | 1.14 | 0.163 | 0.163 | 1.00 | 0.0242 | 0.2385 | 0.101 |
| 0.3071 | 0.6520 | 0.471 | 0.276 | 0.452 | 0.61 | 0.0405 | 0.410 | 0.099 |
| 0.8858 | 4.4528 | 0.199 | 0.477 | 1.104 | 0.433 | 0.0907 | 0.867 | 0.105 |
| 1.2365 | 6.9694 | 0.177 | 0.703 | 2.360 | 0.297 | 0.182 | 1.562 | 0.117 |
| 1.6471 | 8.5095 | 0.194 | 0.897 | 3.790 | 0.236 | 0.314 | 2.529 | 0.124 |
| 1.9839 | 7.6831 | 0.258 | 1.029 | 5.197 | 0.197 | 0.584 | 4.066 | 0.144 |
| 2.4474 | 6.7618 | 0.362 | 1.255 | 6.654 | 0.188 | 1.227 | 6.138 | 0.200 |

### Distribution of Iso Butyric Acid at 25° Between Water and:

(Kolossowsky Kulikow and Bekturow 1934; 1935.)

| Carbon Tetrachloride | | | Nitro Benzene | | |
|---|---|---|---|---|---|
| Gm. Mols. $C_4H_8O_2$ per liter | | $\frac{1}{2}$ | Gm. Mol. $C_4H_8O_2$ per liter | | $\frac{1}{2}$ |
| $H_2O$ layer(1) | $CCl_4$ layer(2) | | $H_2O$ layer(1) | $C_6H_5NO_2$ layer(2) | |
| 0.01425 | 0.00302 | 4.712 | 0.0748 | 0.0561 | 1.33 |
| 0.03048 | 0.01146 | 2.660 | 0.1122 | 0.1029 | 1.09 |
| 0.08922 | 0.04909 | 1.818 | 0.2526 | 0.3555 | 0.711 |
| 0.1675 | 0.1698 | 0.986 | 0.402 | 0.917 | 0.438 |
| 0.3048 | 0.8561 | 0.356 | 0.608 | 1.946 | 0.321 |
| 0.6456 | 3.2122 | 0.201 | 0.720 | 2.676 | 0.261 |
| 0.9521 | 5.8062 | 0.164 | 0.851 | 4.266 | 0.199 |
| 1.2888 | 7.9640 | 0.162 | 0.954 | 5.089 | 0.187 |
| 1.9827(1) | 8.6235 | 0.230 | | | |
| 2.1339(1) | 8.0745 | 0.264 | | | |

(1) In these cases the $H_2O$ layer was the lower.

### Distribution of Iso Butyric Acid at 25° Between Water and:

(Kolossowsky Kulikow and Bekturow 1934; 1935.)

| Normal Amyl Alcohol | | | Iso Amyl Alcohol | | |
|---|---|---|---|---|---|
| Gm. Mol. $C_4H_8O_2$ per liter | | $\frac{1}{2}$ | Gm. Mol. $C_4H_8O_2$ per liter | | $\frac{1}{2}$ |
| $H_2O$ layer(1) | n $C_5H_{11}OH$ layer(2) | | $H_2O$ layer(1) | i $C_5H_{11}OH$ layer(2) | |
| 0.00287 | 0.0262 | 0.109 | 0.0748 | 0.5610 | 0.133 |
| 0.00917 | 0.0898 | 0.102 | 0.1216 | 0.9729 | 0.125 |
| 0.0209 | 0.218 | 0.096 | 0.1590 | 1.3100 | 0.121 |
| 0.0945 | 0.856 | 0.110 | 0.2432 | 1.8900 | 0.129 |
| 0.265 | 2.110 | 0.126 | 0.3461 | 2.5260 | 0.137 |
| 0.582 | 3.948 | 0.147 | 0.5800 | 3.6858 | 0.157 |
| 0.907 | 5.388 | 0.168 | 0.7671 | 4.4156 | 0.174 |
| 1.492 | 6.273 | 0.238 | | | |

## BUTYRIC ACID

### Distribution of Butyric Acid at 25° Between Water and Several Organic Solvents.

(Archibald, 1932.)

| Organic solvent | Gm. Mols. $C_4H_8O_2$ per liter: $H_2O$ layer(1) | Gm. Mols. $C_4H_8O_2$ per liter: Organic layer(2) | $\frac{2}{1}$ |
|---|---|---|---|
| Ethyl methyl ketone | 0.03278 | 0.16644 | 5.077 |
| " " " | 0.12288 | 0.61599 | 5.013 |
| n Butyl alcohol | 0.02109 | 0.18761 | 8.896 |
| " " " | 0.05766 | 0.50350 | 8.732 |
| sec " " | 0.03125 | 0.15963 | 5.108 |
| " " " | 0.09123 | 0.49896 | 5.470 |
| n Amyl alcohol | 0.01552 | 0.17338 | 11.171 |
| " " " | 0.04667 | 0.51912 | 11.123 |
| ter " " | 0.01601 | 0.16697 | 10.367 |
| " " " | 0.05232 | 0.53505 | 10.226 |
| Iso propyl ether | — | — | 2.90 |
| Ethyl ether | — | — | 4.60 |

### Distribution of Butyric Acid at 25° Between Water and Iso Butyl Alcohol.

(Kolossowski, Kulikow & Bektourow, 1936; Kolossowski, Bektourow and Kulikow, 1936.)

| Gm. Mols. $C_4H_8O_2$ per liter: $H_2O$ layer(1) | Gm. Mols. $C_4H_8O_2$ per liter: $i\,C_4H_9OH$ layer(2) | $\frac{1}{2}$ | Gm. Mols. $C_4H_8O_2$ per liter: $H_2O$ layer(1) | Gm. Mols. $C_4H_8O_2$ per liter: $i\,C_4H_9OH$ layer(2) | $\frac{1}{2}$ |
|---|---|---|---|---|---|
| 0.0032 | 0.024 | 0.133 | 0.214 | 1.506 | 0.142 |
| 0.0071 | 0.059 | 0.120 | 0.314 | 2.100 | 0.150 |
| 0.0154 | 0.142 | 0.108 | 0.498 | 3.072 | 0.162 |
| 0.0259 | 0.243 | 0.107 | 0.640 | 3.724 | 0.172 |
| 0.0889 | 0.735 | 0.121 | 0.877 | 4.768 | 0.184 |
| 0.1125 | 0.887 | 0.128 | | | |

### Distribution of Butyric Acid at 25° Between Water and Toluene.

(Kolossowsky and Ponomarev, 1934, 1934a.)

| Gm. Equiv. $C_4H_8O_2$ per liter: $H_2O$ layer(1) | Gm. Equiv. $C_4H_8O_2$ per liter: $C_6H_5CH_3$ layer(2) | $\frac{1}{2}$ | Gm. Equiv. $C_4H_8O_2$ per liter: $H_2O$ layer(1) | Gm. Equiv. $C_4H_8O_2$ per liter: $C_6H_5CH_3$ layer(2) | $\frac{1}{2}$ |
|---|---|---|---|---|---|
| 0.0108 | 0.0018 | 6.00 | 0.1324 | 0.1676 | 0.790 |
| 0.0161 | 0.0039 | 4.10 | 0.1612 | 0.2888 | 0.675 |
| 0.0231 | 0.0069 | 3.32 | 0.1857 | 0.3143 | 0.591 |
| 0.0354 | 0.0146 | 2.42 | 0.2913 | 0.7087 | 0.411 |
| 0.0463 | 0.0237 | 1.955 | 0.613 | 2.387 | 0.257 |
| 0.0611 | 0.0389 | 1.57 | 0.881 | 4.119 | 0.214 |
| 0.0826 | 0.0674 | 1.225 | 1.186 | 5.814 | 0.204 |
| 0.1170 | 0.1330 | 0.88 | 1.406 | 6.894 | 0.204 |

## BUTYRIC ACID

### Distribution of Butyric Acid at 25° Between Water and Ortho Nitro Toluene.

(Kolossowsky and Kulikow, 1934.)

| Gm. Mols. $C_4H_8O_2$ per liter | | $\frac{1}{2}$ | Gm. Mols. $C_4H_8O_2$ per liter | | $\frac{1}{2}$ |
|---|---|---|---|---|---|
| $H_2O$ layer(1) | $C_6H_4CH_3NO_2$ layer(2) | | $H_2O$ layer(1) | $C_6H_4CH_3NO_2$ layer(2) | |
| 0.0350 | 0.0164 | 2.13 | 0.564 | 1.448 | 0.383 |
| 0.0567 | 0.0350 | 1.62 | 0.754 | 2.482 | 0.304 |
| 0.1028 | 0.0801 | 1.28 | 0.878 | 3.381 | 0.260 |
| 0.1541 | 0.1513 | 1.02 | 1.044 | 4.852 | 0.215 |
| 0.239 | 0.319 | 0.749 | 1.223 | 6.418 | 0.191 |
| 0.407 | 0.780 | 0.523 | 1.289 | 6.540 | 0.197 |

### Distribution of Normal Butyric Acid and of Iso Butyric Acid Between Water and Petroleum Ether at Room Temperature.

(Crossfield and Miermeister, 1932.)

Results for Normal Butyric Acid

| cc 0.1 n NaOH per 25 cc | | $\frac{1}{2}$ |
|---|---|---|
| $H_2O$ layer(1) | Pet Ether layer(2) | |
| 0.44 | 0.041 | 10.7 |
| 0.97 | 0.058 | 16.6 |
| 1.21 | 0.063 | 19.2 |
| 3.64 | 0.188 | 16.7 |
| 8.69 | 0.988 | 8.8 |
| 19.3 | 4.46 | 4.33 |
| 47.5 | 26.3 | 1.81 |
| 72.3 | 57.7 | 1.25 |
| 117.0 | 143.0 | 0.82 |

Results for Iso Butyric Acid

| cc 0.1 n NaOH per 25 cc | | $\frac{1}{2}$ |
|---|---|---|
| $H_2O$ layer(1) | Pet. Ether layer(2) | |
| 0.822 | 0.088 | 9.3 |
| 1.459 | 0.126 | 11.6 |
| 5.287 | 0.663 | 7.98 |
| 13.09 | 3.31 | 3.96 |
| 36.27 | 23.48 | 1.55 |
| 70.40 | 91.60 | 0.77 |

### Distribution of Butyric Acid and of Iso Butyric Acid Between Water and Olive Oil.

(Bodansky, 1928; Bodansky and Meigs, 1932.)

Results for Butyric Acid

| t° | Gm. Mols. $C_4H_8O_2$ per liter | |
|---|---|---|
| | $H_2O$ layer | Oil layer |
| 25 | 0.0125 | 0.0198 |
| " | 0.0308 | 0.0488 |
| " | 0.0610 | 0.1010 |
| " | 0.120 | 0.2020 |
| 37.5 | 0.0126 | 0.0206 |
| " | 0.0306 | 0.0496 |
| " | 0.0600 | 0.1000 |
| " | 0.1190 | 0.201 |

Results for Iso Butyric Acid

| t° | Gm. Mols. $C_4H_8O_2$ per liter | |
|---|---|---|
| | $H_2O$ layer | Oil layer |
| 25 | 0.0310 | 0.0490 |
| " | 0.0620 | 0.1020 |
| " | 0.1180 | 0.2030 |
| 37.5 | 0.030 | 0.050 |
| " | 0.061 | 0.102 |
| " | 0.118 | 0.204 |

## TRI BUTYRIN $C_3H_5(C_3H_7COO)_3$.

Results for the reciprocal solubility of tri butyrin and benzene are given by Loskit, 1928.

### Distribution of Normal Butyric Acid Between Methyl Alcohol and i Octane at 0°

(Smith and Norton, 1932.)

i Octane = 2.2.4, Tri methyl Pentane

| Gm. Mols. $C_4H_8O_2$ per liter | | $\frac{1}{2}$ |
|---|---|---|
| i Octane layer(1) | $CH_3OH$ layer(2) | |
| 0.00691 | 0.08120 | 0.0840 |
| 0.01898 | 0.20633 | 0.0916 |

### Distribution of Normal Butyric Acid Between i Octane and β Methoxy Ethanol.

(Henriques, 1933.)

| t° | Gm. Mol. $C_4H_8O_2$ per liter | | $\frac{1}{2}$ | t° | Gm. Mol. $C_4H_8O_2$ per liter | | $\frac{1}{2}$ |
|---|---|---|---|---|---|---|---|
| | i Octane layer(1) | Ethanol layer (2) | | | i Octane layer(1) | Ethanol layer (2) | |
| -19.5 | 0.0019 | 0.0822 | 0.023 | 0 | 0.0049 | 0.104 | 0.047 |
| " | 0.0058 | 0.2154 | 0.027 | " | 0.0099 | 0.1962 | 0.050 |
| " | 0.0104 | 0.4103 | 0.025 | " | 0.0124 | 0.2470 | 0.050 |
| 0 | 0.0034 | 0.0777 | 0.044 | " | 0.0164 | 0.3022 | 0.054 |
| " | 0.0040 | 0.0799 | 0.050 | " | 0.0211 | 0.3827 | 0.055 |

### Data for the Following Ternary Systems Containing Normal Butyric Acid are Given by Timmermans, 1907.

Normal Butyric acid + Water + Azobenzene.
" " " " + Barium nitrate.
" " " " + Benzophenone.
" " " " + Camphor.
" " " " + Cane sugar.
" " " " + Mannite.
" " " " + Naphthalene.
" " " " + Potassium sulfate.
" " " " + Sodium chloride.

Freezing-point data are given for mixtures of *n* butyric acid and formamide by English and Turner (1915), and for mixtures of trichlorobutyric acid and dimethyl pyrone by Kendall (1914).

Freezing-point lowering data for mixtures of butyric acid and *o* phenylene diamine are given by Kremann, Weber and Zechner, 1925.

Results for mixtures of Iso Butyric acid and Propionic acid and for Iso Butyric acid and Iso Valeric acid are given by Timmermans, 1934.

## Oxy**BUTYRIC ACIDS** α and β $CH_3.CH_2.CH(OH)COOH$.

### Distribution of α and of β Oxy Butyric Acids at 25° Between Water and Ethyl Ether. (Smith, 1921-1922.)

Results for α Oxy Butyric Acid.

| Millimols. α $CH_3.CH_2.CH(OH)COOH$ per liter of | | $\frac{C_2}{C_1}$. |
|---|---|---|
| $H_2O$ layer ($C_1$). | $(C_2H_5)_2O$ layer ($C_2$). | |
| 1.7625 | 1.0875 | 0.617 |
| 2.875 | 1.875 | 0.652 |
| 4.1375 | 2.7125 | 0.656 |
| 5.75 | 3.55 | 0.617 |
| 9.70 | 6.40 | 0.660 |

Results for β Oxy Butyric Acid

| Millimols. β $CH_3.CH_2.CH(OH)COOH$ per liter of | | $\frac{C_2}{C_1}$ |
|---|---|---|
| $H_2O$ layer ($C_1$) | $(C_2H_5)_2O$ layer ($C_2$). | |
| 1.075 | 0.375 | 0.349 |
| 1.725 | 0.600 | 0.348 |
| 3.05 | 1.075 | 0.352 |
| 4.75 | 1.70 | 0.358 |
| 6.60 | 2.36 | 0.356 |

### Distribution of α Oxy Butyric Acid at 20° Between Water and:
(Dietzel and Schmitt, 1932.)

| Ethyl Ether | | Amyl Alcohol | |
|---|---|---|---|
| Gm. Mol. $C_4H_8O_2$ per liter | | Gm. Mol. $C_4H_8O_2$ per liter | |
| $H_2O$ layer | Ether layer | $H_2O$ layer | Alcohol layer |
| 0.232 | 0.0733 | 0.218 | 0.2325 |
| 0.412 | 0.1442 | 0.398 | 0.4419 |
| 0.592 | 0.2221 | 0.638 | 0.7211 |
| 0.817 | 0.3151 | 0.878 | 1.0003 |
| 1.177 | 0.4639 | 1.178 | 1.3493 |

**DIOXANE** p (1,4) $O\langle CH_2CH_2\rangle O\langle CH_2CH_2\rangle$.

### Freezing-points of Mixtures of Dioxane and Water.

| Results of Gillis and Delaunois, 1934 | | | Results of Hovorka, Schaefer and Dreisbach, 1936 | | |
|---|---|---|---|---|---|
| $t^o$ | Gms. $C_4H_8O_2$ per 100 gms. sat. sol. | Solid Phase | $t^o$ | Mol. fraction $C_4H_8O_2$ in sat. sol. | Solid Phase |
| - 1.79 | 9.382 | Ice | -10.1 | 0.0855 | Ice |
| - 7.55 | 25.73 | " | -10.8 | 0.0905 | " |
| -11.2 | 34.37 | " | -11.6 | 0.1011 | " |
| -13.72 | 40.81 | " | -12.7 | 0.1140 | " |
| -14.05 | 43.22 | " | -14.9 Eutec. | 0.1515 | " + p $C_4H_8O_2$ |
| -14.82 Eutec. | — | " p $C_4H_8O_2$ | -11.1 | 0.1830 | p $C_4H_8O_2$ |
| - 9.28 | 50.86 | p $C_4H_8O_2$ | - 3.6 | 0.2500 | " |
| - 4.35 | 61.15 | " | - 0.7 | 0.3219 | " |
| - 2.51 | 66.47 | " | + 1.0 | 0.4007 | " |
| + 1.95 | 80.04 | " | 1.5 | 0.4285 | " |
| 3.42 | 87.35 | " | 2.8 | 0.5202 | " |
| 3.87 | 89.44 | " | 3.7 | 0.6074 | " |
| 4.07 | 90.23 | " | 3.9 | 0.6351 | " |
| 4.71 | 91.87 | " | 5.0 | 0.7296 | " |
| 5.27 | 94.07 | " | 5.4 | 0.7633 | " |
| 5.80 | 95.45 | " | 7.5 | 0.8760 | " |
| 7.81 | 96.97 | " | 8.7 | 0.9208 | " |
| 11.6 | 100.00 | " | 11.78 | 1.000 | " |

The curve of Gillis & Delaunois shows a peculiar trend in the region of high dioxane content which was not found by Hovorka, Schaefer and Dreisbach. Results for the boiling points, densities and refractive indices of aqueous dioxane mixtures are given by Gillis and Delaunois. Results for the densities, refractive indices, surface tensions, vapor pressures and partial molar volumes of mixtures of water and dioxane are given by Hovorka, Schaefer and Dreisbach.

Freezing-point data are given for:

p Dioxane + Butanol (Getman, 1937.)
+ Di Iodo Ethane (Rheinboldt and Luyken, 1932.)
+ Di Iodo Ethylene " " "

**DIMETHYL GLYOXIME** $CH_3C(:NOH)C(:NOH)CH_3$.

Freezing-points of mixtures of dimethyl glyoxime and antipyrine, of methyl glyoxime and antipyrine and of methyl ethyl glyoxime and antipyrine are given by Semeria and Bocca, 1926.

**SUCCINAMIDE** $(CH_2)_2(CONH_2)_2$.

100 cc. $H_2O$ dissolve 1.836 gm. succinamide at 50°. (Viseur, 1926.)

Freezing-point data for mixtures of succinamide and Fumaride and of succinamide and malemanide are given by Viseur, 1926.

**MALAMIDE** (Malic amide) 1 $C_2H_3(OH)(CONH_2)_2$.

FREEZING-POINTS OF MIXTURES OF LAEVO MALAMIDE AND WATER.
(Timmermans and Mme. Vesselovsky, 1932.)

| t° | Gms. $C_4H_8O_3N_2$ per 100 gms. $H_2O$ | t° | Gms. $C_4H_8O_3N_2$ per 100 gms. $H_2O$ |
|---|---|---|---|
| -0.75 | 5.0 | -2.45 | 20.0* |
| -1.35 | 10.0 | -3.55 | 30.0* |
| -2.0 | 15.0 | -4.20 | 40.0* |

* Metastable region. The eutectic point is at -2.30°.

These authors also give data for the freezing-points of mixtures of d and l malamide and of mixtures of malamides and tartaric amides.

**GLYCYLGLYCINE** $NH\langle^{CO.CH_2NH_2}_{CH_2COOH}$

| Solvent. | t°. | Gms. $C_4H_8O_3N_2$ per 100 cc. sat. sol. | Authority. |
|---|---|---|---|
| Water..... | 18.5 | 19.09 | (von Euler and Rudberg, 1924, 1925. |
| ..... | 21.0 | 19.81 | (Pfeiffer and Angern, 1924.) |
| Aq. 0.1*m* NaCl | 18.5 | 10.57 | (von Euler and Rudberg, 1924, 1925.) |

SOLUBILITY OF GLYCYL GLYCINE IN AQUEOUS ETHYL ALCOHOL AT 25°.
(McMeekin, Cohn and Weare, 1935.)

| Vol. Percent $C_2H_5OH$ in aq. solvent | d. of sat. sol. | Gm. Mol. $C_4H_8O_3N_2$ per liter sat. solution | Vol. Percent $C_2H_5OH$ in aq. solvent | d. of sat. sol. | Gm. Mol. $C_4H_8O_3N_2$ per liter sat. solution |
|---|---|---|---|---|---|
| 0.0 | 1.0779 | 1.512 | 80.0 | 0.8554 | 0.00374 |
| 20.0 | 1.0019 | 0.531 | 90.0 | 0.8250 | 0.000493 |
| 40.0 | 0.9541 | 0.152 | 100.0 | 0.7851 | 0.0000222 |
| 60.0 | 0.9082 | 0.0362 | | | |

**ASPARAGINE** $C_4H_8N_2O_3.H_2O$.

SOLUBILITY β-*l*-ASPARAGINE, $C_4H_8N_2O_3.H_2O$, AND OF β-*l*-ASPARAGINIC ACID, $C_4H_7NO_4$, IN WATER.

(Bresler — Z. physik. Chem. 47, 613, '04.)

| β-*l*-Asparagine. | | | | β-*l*-Asparaginic Acid. | | | |
|---|---|---|---|---|---|---|---|
| t°. | Gms. $C_4H_8N_2O_3.H_2O$ per 100 g. $H_2O$. | t°. | Gms. $C_4H_8N_2O_3.H_2O$ per 100 g. $H_2O$. | t°. | Gms. $C_4H_7NO_4$ per 100 g. $H_2O$. | t°. | Gms. $C_4H_7NO_4$ per 100 g. $H_2O$. |
| 0.7 | 0.9546 | 55.5 | 10.650 | 0.2 | 0.2674 | 51.0 | 1.2746 |
| 7.5 | 1.4260 | 71.7 | 19.838 | 9.5 | 0.4042 | 63.5 | 1.8147 |
| 17.5 | 2.1400 | 87.0 | 36.564 | 16.4 | 0.5176 | 70.0 | 2.3500 |
| 28.0 | 3.1710 | 98.0 | 52.475 | 31.5 | 0.7514 | 80.5 | 3.2106 |
| 41.4 | 5.6500 | | | 40.0 | 0.9258 | 97.4 | 5.3746 |

100 gms. $H_2O$ dissolve 2.4 gms. asparagine at 20°–25°. (Dehn, 1917.)
100 gms. pyridine dissolve 0.03 gm. asparagine at 20°–25°. "
100 gms. 50% aq. pyridine dissolve 0.15 gm. asparagine at 20°–25°. "
100 gms. trichlorethylene dissolve 0.018 gm. asparagine at 15°. (Wester & Bruins, 1914.)

Data for the solubility of asparaginic acid in aqueous salt solutions are given by Würgler (1914).

100 cc. sat. solution of Asparigine in Water contain 1.12 gm. $C_4H_8N_2O_3$ at 21-22° (Pfeiffer and Angern, 1924.)
100 gms abs Alcohol dissolve 0.02 gm. Asparigine at 20–25° (Pucher and Dehn, 1921)
" Quinoline " 0.11 " " " " " "
" equi. mol. mixture of Alcohol and Quinoline dissolve 0.18 gm. Asparigine at 20–25° (Pucher and Dehn, 1921.)

SOLUBILITY OF l ASPARAGINE IN WATER.

(Dalton and Schmidt, 1935.)

The results of 26 determinations at nine temperatures between 0° and 65° were used for calculating the solubility equation and from this the following values for 5° intervals were obtained. The results above 70° are probably less accurate than those at lower temperatures. Density determinations at 25° for solutions less than saturated are also given.

| t° | Gms. $C_4H_8O_3N_2.H_2O$ per 100 gms. $H_2O$ | t° | Gms. $C_4H_8O_3N_2.H_2O$ per 100 gms. $H_2O$ | t° | Gms. $C_4H_8O_3N_2.H_2O$ per 100 gms. $H_2O$ |
|---|---|---|---|---|---|
| 0 | 0.849 | 30 | 3.779 | 60 | 13.68 |
| 5 | 1.105 | 35 | 4.750 | 65 | 16.62 |
| 10 | 1.429 | 40 | 5.937 | 70 | 20.06 |
| 15 | 1.838 | 45 | 7.377 | 75 | 24.09 |
| 20 | 2.351 | 50 | 9.118 | 100 | 55.17 |
| 25 | 2.989 | 55 | 11.20 | | |

FREEZING-POINTS OF AQUEOUS SOLUTIONS OF l ASPARAGINE.

(Timmermans and Heuse 1931.)

| t° | Gms. $C_4H_8O_3N_2$ per 100 gms. $H_2O$ | t° | Gms. $C_4H_8O_3N_2$ per 100 gms. $H_2O$ |
|---|---|---|---|
| -0.09 | 0.45 | -0.16 Eutec. | 0.82 |
| -0.12 | 0.63 | -0.17 | 0.90 |
| -0.15 | 0.75 | -0.23 | 1.40 |

10 cc of a saturated cold aqueous solution of $Mg(ClO_4)_2$ dissolve 5.0 gms. asparagine. (Duclaux and Durand-Gasselin, 1938.)

### Solubility of l Asparagine in Aqueous Ethyl Alcohol at 25°.

(McMeekins Cohn and Weare 1935.)

| Vol. Percent $C_2H_5OH$ in aq. solvent | d. of sat. sol. | Gm. Mol. $C_4H_8O_3N_2$ per liter sat. sol. |
|---|---|---|
| 0.0 | 1.0072 | 0.186 (= 24.57 gms.) |
| 20.0 | 0.9761 | 0.075 |
| 40.0 | 0.9473 | 0.0306 |
| 60.0 | 0.9068 | 0.0105 |
| 100.0 | 0.7852 | 0.000023 |

Freezing-point data are given for:

l Asparagine + l dichloro succinic acid (Timmermans, Van Lancken and Jaffe, 1939.)
" + d " " " " " "
" + d Tartaric acid + $H_2O$ (Timmermans and Heuse, 1931.)
" + phenyl glycolic acid (Timmermans and Motiuk, 1932.)

## METHYL HYDANTOIC ACID $NH_2CONHCH(CH_3)COOH$.

### Solubility of Methyl Hydantoic Acid in Aqueous Ethyl Alcohol at 25°.

(McMeekin, Cohn and Weare, 1935.)

| Vol. Percent $C_2H_5OH$ in aq. solvent | d. of sat. sol. | Gm. Mol. $C_4H_8O_3N_2$ per liter sat. sol. | Vol. Percent $C_2H_5OH$ in aq. solvent | d. of sat. sol. | Gm. Mol. $C_4H_8O_3N_2$ per liter sat. sol. |
|---|---|---|---|---|---|
| 0.0 | 1.0045 | 0.193 | 60.0 | 0.9160 | 0.223 |
| 20.0 | 0.9795 | 0.187 | 80.0 | 0.8649 | 0.173 |
| 40.0 | 0.9541 | 0.212 | 100.0 | 0.7877 | 0.044 |

## β ALANINE HYDANTOIC ACID $C_4H_8O_3N_2$.

### Solubility of β Alanine Hydantoic Acid in Water and in Ethyl Alcohol.

(McMeekin, Cohn and Weare, 1936.)

| Solvent | t° | d. of sat. sol. | Gm. Mol. $C_4H_8O_3N_2$ per liter sat. sol. |
|---|---|---|---|
| Water | 25 | 1.00287 | 0.158 |
| Ethyl alcohol | 25 | 0.78692 | 0.017 |

## Ethyl, Methyl. etc. ALLOPHANATES $NH_2.CO.NH.COOC_2H_5$.

### Solubilities in Ethylalcohol and, in Ether. (Béhal, 1919.)

As a method of isolation and identification, an extensive series of alcohols were converted into the corresponding allophanates by the action upon them of cyanic acid. This gas was prepared by the depolymerization of cyanuric acid at about 300° in a very slow current of $CO_2$, and when passed into the cooled alcohol gave rise to the general reaction, $2\,O.C.NH + C_2H_5OH = NH_2.CO.NH.COOC_2H_5$, which proceeded rapidly with evolution of heat and brisk solidification of the mixture. In each case the product, after cooling, was washed with ether, to remove unchanged alcohol and urethan, which is simultaneously formed in greater or less amount. The allophanates were then each purified by dissolving in warm alcohol, benzene or acetone and crystallizing by cooling. They were all crystalline and only slightly soluble in alcohol and ether. The author does not describe the procedure followed in determining the solubilities which he reports. In a private communication he states that « 10 cc. of each of the saturated solutions were evaporated to dryness and the residue weighed after standing in a desiccator containing sulfuric acid ». The figures in parentheses show the melting-points of the allophanates.

| Allophanate of : (Primary alcohols). | t°. | Gms. Allophanate per 10 cc. of Alcohol. | Gms. Allophanate per 10 cc. of Ether. | Allophanate of : (Primary alcohols) | t°. | Gms. Allophanate per 10 cc. of Alcohol. | Gms. Allophanate per 10 cc. of Ether. |
|---|---|---|---|---|---|---|---|
| Ethyl (190°)..... | 20 | 0.455 | 0.080 | Heptyl (160°)..... | 17 | 0.350* | 0.120 |
| Methyl (212°)... | 17 | 0.140 | 0.030 | Octyl (157°)..... | 17 | 0.220* | 0.140 |
| Propyl (175°.5) . | 17 | 0.750 | 0.139 | Nonyl (158°) ..... | 17–13 | 0.120* | 0.091 |
| *n* Butyl (150°).. | 18 | 1.230 | 0.246 | Decyl (159°)..... | 17 | 0.054* | 0.058 |
| Iso Butyl (180°.5) | 15 | 0.947 | 0.302 | Undecyl (155°)... | 13 | 0.105* | 0.117 |
| Iso Amyl (150°). | 13 | 1.411* | 0.698 | Dodecyl (159°.5).. | 17 | 0.015* | 0.025 |
| Hexyl (165°)... | 17 | 0.480* | 0.120 | Allyl (165°)..... | 18 | 0.855 | 0.212 |
| Iso Hexyl (190°) | 14 | 0.471* | 0.220* | Undecylenyl (143°) | 17 | 0.642 | 0.181 |

* Absolute alcohol or ether was used in these cases.

### Solubilities of Allophanates in Ethylalcohol and in Ether (*Con.*).

| Allophanates of Secondary and Tertiary alcohols. | t°. | Gms. Allophanate per 10 cc. of Alcohol. | Gms. Allophanate per 10 cc. of Ether. | Allophanates of Aryl alcohols, Cyclic alcohols, and Phenols. | t° | Gms. Allophanate per 10 cc. of Alcohol. | Gms. Allophanate per 10 cc. of Ether. |
|---|---|---|---|---|---|---|---|
| Propanol.2 (180)... | 16 | 0.815* | 0.321* | Benzyl (121)... | 17 | 0.220 | 0.050 |
| Me Et Carbinol (159.5). | 18 | 0.748 | 0.571 | Phenylethyl (186)... | 17 | 0.080 | 0.033 |
| Me Pr » (154)... | 18 | 0.535 | 0.531 | » propyl (165)... | 16.5 | 0.157 | 0.089 |
| Di Et » (179.5). | 18 | 0.996 | 0.457 | Me Salicgenine (180)... | 17 | 0.106 | 0.064 |
| Me Bu » (173)... | 17 | 0.970 | 0.300 | Anisyl (180.2). | 17 | 0.070 | 0.016 |
| Et iso Pr » (179)... | 19 | 1.361* | 0.485 | Et Vanillyl (173)... | 17 | 0.039 | 0.014 |
| Me iso Bu » (161)... | 16.5 | 0.288 | 0.198 | Piperonyl (176.5). | 16.5 | 0.066 | 0.023 |
| Di Pr » (206)... | 16.5 | 0.410 | 0.191 | Phenyl ethyl (Sec.) (181.5). | 19 | 0.680 | 0.016 |
| Octyl » (155)... | 14 | 0.204* | 0.069 | Cyclo (6) (148)... | 17 | 0.238 | 0.070 |
| Di iso Bu » (156)... | 16.5 | 1.158 | 1.064 | Cinnamyl (185)... | 17 | 0.810 | 0.050 |
| Tri Me » (190)... | 15 | 0.723* | 0.290 | Cyclo pentanyl (179.5). | 17 | 0.978 | 0.329 |
| Amyl » (152)... | 16 | 1.125* | 0.289 | » hexanyl (179)... | 20 | 0.834 | 0.247 |
| Hexyl (1) (128)... | 16 | 2.400* | 0.965 | Menthyl (213)... | 18 | 0.140 | 0.067 |
| Heptyl (2) (132)... | 14 | 0.920* | 0.446 | Carvon (7) (192.3). | 17 | 0.228 | 0.026 |
| Octyl (3) (149)... | 16 | 1.144* | 0.531* | Menthyl (tery) (187)... | 17 | 0.180 | 0.070 |
| Nonyl (4) (145)... | 16 | 1.340* | 0.891* | Iso pulegyl (219)... | 17 | 0.263 | 0.222 |
| Di Me (5) (113.5). | 14 | 0.642* | 0.793* | Phenyl (180)... | 19 | 0.381 | 0.036 |
| | | | | *o* cresyl (185)... | 18 | 0.171 | 0.063 |
| | | | | *p* » (194)... | 18 | 0.279 | 0.092 |

* In absolute alcohol or ether.

(1) Methyl-2-pentanol-5; (2) Dimethyl-2.4-Pentanol-2; (3) Ethyl-3-Hexanol-3; (4) Methyl-2-Ethyl-4-Hexanol-4; (5) Dimethylnonylcarbinol; (6) Cyclohexylbutanyl; (7) Carvon menthyl.

TARTRAMIDE d $(CHOH.CONH_2)_2$.

FREEZING-POINTS OF MIXTURES OF DEXTRO TARTRAMIDE AND WATER.
(Timmermans and Mme. Vesselovsky, 1932.)

| t° | Gms. $C_4H_8O_4N_2$ per 100 gms. $H_2O$ |
|---|---|
| -0.40 | 3.0 |
| -0.75 | 6.0 |
| -0.80 Eutectic | — |
| -1.00 | 9.0 |
| -1.30 | 12.0 |

Freezing-point data are also given for mixtures of d and l Tartramide and for mixtures of tartramide and malamide.

## BUTYL BROMIDE, CHLORIDE, IODIDE etc.

APPROXIMATE SOLUBILITY OF EACH IN WATER.
(Führer, 1924.)

| Componnd. | Formula. | | t°. | Gms. cmpd. per 100 gms. sat. sol. |
|---|---|---|---|---|
| Butyl bromide..... | $CH_3(CH_2)_2CH_2Br$ | (1.23) | 16 | 0.058 |
| Iso Butyl bromide..... | $(CH_3)_2CH.CH_2Br$ | (1.21) | 18 | 0.051 |
| Butyl chloride..... | $CH_3(CH_2)_2CH_2Cl$ | (0.86) | 12.5 | 0.066 |
| Iso Butyl chloride..... | $(CH_3)_2CH.CH_2Cl$ | (0.86) | 12.5 | 0.92 |
| Butyl iodide..... | $CH_3(CH_2)_2CH_2I$ | (1.54) | 17.5 | 0.021 |
| Iso Butyl urethan..... | $(CH_3)_2CH.CH_2NHCO_2.C_2H_5$ | | 15.5 | 2.00 |

The figures in parentheses are the approximate specific gravities of the compounds.

100 gms. $H_2O$ dissolve 0.608 gm. $C_4H_9Br$ at 30°. (Gross and Saylor, 1931.)

Freezing-point data are given by Timmermans, 1934, for the following mixtures.

n Butyl Bromide + Ethyl Bromide
" " + iso Butyl "
iso " " + $CS_2$
" " " + Ethyl Bromide
" " " + n Propyl "

iso Butyl Bromide + ter Butyl Chloride
" " " + Methylene "
" " " + Ethylidene "
n " Chloride + ter Butyl "

dl α **AMINO n BUTYRIC ACID** $CH_3CH_2CH(NH_2)COOH$.

dl α **AMINO iso BUTYRIC ACID** $(CH_3)_2C(NH_2)COOH$.

SOLUBILITY OF EACH SEPARATELY IN AQUEOUS ETHYL ALCOHOL SOLUTIONS AT 25°.
(Cohn, McMeekin, Edsall and Weare, 1934.)

| Vol. Percent $C_2H_5OH$ in Aq. Solvent | Results for α Amino n Butyric Acid: d. of sat. sol. | Gm. Mols. $C_4H_9O_2$ per liter sat. sol. | Results for α Amino Iso Butyric Acid: d. of sat. sol. | Gm. Mols. $C_4H_9O_2$ per liter sat. sol. |
|---|---|---|---|---|
| 0.0 | 1.0456 | 1.800 (= 185.6 gms.) | 1.0312 | 1.330 (= 137.2 gms. |
| 5.0 | 1.0370 | 1.634 | — | — |
| 10.0 | 1.0264 | 1.464 | — | — |
| 15.0 | 1.0166 | 1.287 | — | — |
| 20.0 | 1.0043 | 1.082 | 0.9947 | 0.775 |
| 40.0 | 0.9629 | 0.570 | 0.9577 | 0.401 |
| 60.0 | 0.9147 | 0.260 | 0.9111 | 0.177 |
| 80.0 | 0.8586 | 0.0668 | 0.8578 | 0.0467 |
| 100.0 | 0.7851 | 0.0026 | — | — |

DISTRIBUTION OF α AMINO n BUTYRIC ACID BETWEEN WATER AND BUTYL ALCOHOL AT 25°.
(England, Albert, Jr., and Cohn, 1936.)

| Gm. Mols. $C_4H_9O_2$ per liter | | $\frac{2}{1}$ |
|---|---|---|
| $H_2O$ layer (1) | Butyl alc. layer (2) | |
| 0.396 | 0.0166 | 0.0420 |
| 0.577 | 0.0228 | 0.0394 |
| 1.094 | 0.0386 | 0.0352 |
| 1.614* | 0.0513* | 0.0318 |

*Saturated with respect to Amino n Butyric Acid.

**METHYL URETHAN** $CH_3.NHCOOC_2H_5$.

100 gms. $H_2O$ dissolve 222.6 gms. $C_4H_9NO_2$ at 15.5°. (Führer, 1924.)

**BUTANE** $C_4H_{10}$.

SOLUBILITY IN WATER AT $t$° AND 760 MM.

| $t$°. | 0°. | 4°. | 10°. | 15°. | 20°. |
|---|---|---|---|---|---|
| Vol. $C_4H_{10}$ per 100 vols. $H_2O$ | 3.147 | 2.77 | 2.355 | 2.147 | 2.065 |

The upper critical solution temperature of Butane in Sulfur Dioxide is −4.7° and the mixture contains 72 Wt. % $SO_2$. (Seyer and Todd, 1931; Leslie, 1934.)

**BUTYL ALCOHOL** *normal* $CH_3.(CH_2)_2CH_2OH$.

SOLUBILITY IN WATER, DETERMINED BY THE SYNTHETIC METHOD. (Führer, 1924.)

| t° | Gms. $CH_3(CH_2)_2CH_2OH$ per 100 gms. sat. sol. | t°. | Gms. $CH_3(CH_2)_2CH_2OH$ per 100 gms. sat. sol. | t°. | Gms. $CH_3(CH_2)_2CH_2OH$ per 100 gms. sat. sol. |
|---|---|---|---|---|---|
| 0..... | 10.45 | 40..... | 6.55 | 80..... | 7.00 |
| 10..... | 9.00 | 50..... | 6.35 | 90..... | 7.80 |
| 20..... | 7.90 | 60..... | 6.35 | 100..... | 9.05 |
| 30..... | 7.10 | 70..... | 6.55 | 110..... | 10.90 |

The original results were plotted and the above table constructed from the curve.

## Mutual Solubility of Normal Butyl Alcohol and Water.

(Hill and Malisoff, 1926.)

Highly purified butyl alcohol was employed. The determinations were made in the two-bulbed solubility flasks previously described.

(*J. Am. Chem. Soc.*, **45**, 1143, 1923.)

| | Butyl Alcohol Phase. | | Water Phase. | | |
|---|---|---|---|---|---|
| t° | Gms. $CH_3(CH_2)_2CH_2OH$ per 100 gms. sat. sol. | Density of sat. sol. | | Gms. $CH_3(CH_2)_2CH_2OH$ per 100 gms. sat. sol. | Density of sat. sol. |
| 5..... | 80.38 | 0.8598 | | 9.55 | 0.9883 |
| 10..... | 80.33 | 0.8567 | | 8.91 | 0.9877 |
| 15..... | 80.14 | 0.8533 | | 8.21 | 0.9881 |
| 20..... | 79.93 | 0.8484 | | 7.81 | 0.9873 |
| 25..... | 79.73 | 0.8450 | | 7.35 | 0.9865 |
| 30..... | 79.38 | 0.8424 | | 7.08 | 0.9851 |
| 35..... | 78.94 | 0.8397 | | 6.83 | 0.9835 |
| 40..... | 78.59 | 0.8345 | | 6.60 | 0.9841 |
| 50..... | 77.58 | 0.8307 | | 6.46 | 0.9799 |
| 60..... | 76.38 | 0.8253 | | 6.52 | 0.9766 |
| 70..... | 74.79 | 0.8200 | | 6.73 | 0.9721 |
| 80..... | 73.53 | 0.8159 | t° | 6.89 | 0.9675 |
| 92..... | 69.24 | – | 97.9..... | 8.74 | – |
| 106.1..... | 63.88 | – | 114.5..... | 12.73 | – |
| 122.3..... | 49.85 | – | 116.9..... | 13.46 | – |
| 124.3..... | 42.02 | – | 123.3..... | 19.73 | – |
| 125.15..... | 32.82 | – | 124.83..... | 27.26 | – |
| | | | 125.10..... | 32.82 | – |
| | | | 125.15..... | 30.44 | – |

The quadruple point is at $-2°.95$. The consolute solution contains 32.5 gms. $CH_3(CH_2)_2CH_2OH$ per 100 gms. sat. solution at the critical solution temperature 125°.15. These values as given by Drouillon, 1925, are respectively 28.0 gms. and 129°.5. As given by Brun (1925) they are respectively 34.0 gms. and 129°.

## Mutual Solubility of Normal Butyl Alcohol and Water.

(Jones, 1929.)

The synthetic method was used. It was found that ordinary soda glass could not be used for accurate determinations. Well steamed Pyrex glass gave results identical with those obtained in quartz-glass tubes in the neighborhood of the critical solution temperature.

| t° | Gms. $C_4H_9OH$ per 100 gms. sat. sol. | t° | Gms. $C_4H_9OH$ per 100 gms. sat. sol. | t° | Gms. $C_4H_9OH$ per 100 gms. sat. sol. |
|---|---|---|---|---|---|
| -18.01 | 12.74(1) | 122.45 | 17.51 | 124.05 | 41.30 |
| - 3.11 | 9.79(1) | 124.74 | 27.88 | 123.75 | 44.03 |
| +19.3 | 6.47(1) | 124.74 | 24.16 | 122.60 | 48.01 |
| 40.0 | 6.03(1) | 124.73 | 30.39 | 115.00 | 57.80 |
| 65.0 | 6.03 | 124.75(C.S.T.) | 32.4 | 106.05 | 63.44 |
| 81.0 | 6.47 | 124.75 | 32.85 | 58.50 | 76.27 |
| 107.72 | 9.79 | 124.72 | 33.79 | 29.82 | 79.51 |
| 117.49 | 12.72 | 124.66 | 38.05 | 13.0 | 80.40 |
| 120.30 | 15.15 | | | 5.0 | 80.82 |

(1) = the lower miscibility temperature in mixtures which have both a lower and an upper miscibility temperature. A maximum solubility on the alcohol rich arm of the curve or a metastable lower C.S.T. was not found.

The above results when plotted yield a curve from which the following values for regular intervals of temperature were taken.

| t° | Gms. $C_4H_9OH$ per 100 gms. $H_2O$ rich phase | Gms. $C_4H_9OH$ per 100 gms. $C_4H_9OH$ rich phase | t° | Gms. $C_4H_9OH$ per 100 gms. $H_2O$ rich phase | Gms. $C_4H_9OH$ per 100 gms. $C_4H_9OH$ rich phase |
|---|---|---|---|---|---|
| -15 | 12.0 | 81.0 | 90 | 7.8 | 69.8(3) |
| 0 | 9.1 | 80.6 | 100 | 8.2 | 66.4 |
| +20 | 6.4 | 80.2 | 105 | 9.8 | 64.3(3) |
| 25 | 7.31 | 79.69(1) | 110 | 10.2 | 61.5 |
| 25 | 7.45 | 79.5((2) | 115 | 11.7 | 57.8 |
| 40 | 6.0 | 78.6 | 120 | 14.7 | 52.5 |
| 60 | 6.0 | 76.2 | 123 | 19.0 | 46.8 |
| 75 | 6.8 | 73.7 (3) | 124.75 | 32.4 | 32.4 |
| 80 | 6.4 | 72.7 | | | |

(1) Butler, Thomson and Maclennen, 1933; (2) Stockhardt and Hull, 1931; (3) Mueller, Rigsley and Ferguson, 1931.

The following additional determinations of the mutual solubility of n Butyl alcohol and Water are given by Butler Thomson & Maclennen, 1933.

| t° | Gms. $C_4H_9OH$ per 100 gms. sat. sol. | t° | Gms. $C_4H_9OH$ per 100 gms. sat. sol. | t° | Gms. $C_4H_9OH$ per 100 gms. sat. sol. |
|---|---|---|---|---|---|
| 22.6 | 7.497 | 28.06 | 7.090 | 27.45 | 79.50 |
| 24.85 | 7.318 | 29.18 | 7.016 | 23.40 | 79.73 |
| 26.40 | 7.202 | 30.83 | 7.928 | 18.45 | 80.01 |

## BUTYL ALCOHOL

100 gms. aq. 0.2 n NaOH dissolve 59.0 gms. n $C_4H_9OH$ at 20°. (Smith, 1932.)

Results showing the effect of Glycine and of α Amino Butyric Acid upon the solubility of Butyl Alcohol in water are given by England and Cohn, 1935.

### Equilibrium in the System Normal Butyl Alcohol Benzene and Water at 19°.

(Perrakis, 1925.)

The amount of water required to produce clouding in various mixtures of benzene and butyl alcohol was determined by a titration method.

| Wt. % $C_4H_9OH$ in mixture | Gms. $H_2O$ to cause clouding in 100 gms. mixture | Wt. % $C_4H_9OH$ in mixture | Gms. $H_2O$ to cause clouding in 100 gms. mixture |
|---|---|---|---|
| 15.75 | 0.8553 | 34.92 | 3.9640 |
| 21.02 | 1.4898 | 36.78 | 4.4925 |
| 26.68 | 2.2610 | 38.54 | 4.9916 |
| 30.26 | 2.8315 | 42.28 | 5.8673 |
| 32.84 | 3.4035 | 56.16 | 9.3456 |

## BUTYL ALCOHOL *iso* $(CH_3)_2CH.CH_2OH$.

### Mutual Solubility of Iso Butyl Alcohol and Water. (Michels, 1922.)

Commercial iso butyl alcohol was fractionated into 10 portions and only those which distilled at a constant temperature were used for the solubility determinations. The density was 0.8197. The determinations were made by the sealed tube method. The numerous determinations of the author were plotted and the following values obtained from the curve.

| | Gms. $(CH_3)_2CH.CH_2OH$ per 100 gms. | |
|---|---|---|
| t°. | $H_2O$ rich layer. | Iso Butyl Alcohol rich layer. |
| −10..... | 13.4 | 86.2 |
| 0..... | 11.5 | 85.4 |
| +10..... | 9.8 | 84.4 |
| 20..... | 8.5 | 83.6 |
| 30..... | 7.5 | 82.7 |
| 40..... | 7.0 | 81.6 |
| 50..... | 6.6 | 80.4 |
| 60..... | 6.4 | 79.0 |
| 70..... | 6.6 | 77 2 |
| 80..... | 7.2 | 75.2 |
| 90..... | 8.1 | 73.2 |
| 100..... | 9.3 | 70.2 |
| 110..... | 11.2 | 66.7 |
| 120..... | 14.0 | 61.5 |
| 125..... | 16.5 | 57.5 |
| 130..... | 21.0 | 51.5 |
| 131..... | 23.0 | 49.0 |
| 132..... | 26.0 | 45.0 |
| 132.8 (crit. t.)..... | 37.0 | |

A small scale diagram, without numerical data, is given for the above system by Brun, 1925. The critical solution temperature is stated to be 123.5° and the corresponding concentration, 37.5 gms. iso butyl alcohol per 100 gms. sat. solution. This author also gives two diagrams and several determinations of tie lines for the system iso butyl alcohol, ethyl alcohol and water.

## BUTYL ALCOHOL (Secondary) $CH_3.CHOH.CH_2CH_3$.

### The Mutual Solubility of Secondary Butyl Alcohol and Water at High Pressures. (Timmermans, 1922.)

The following data for the critical temperature of solution at high pressures are given.

The constants of the secondary butyl alcohol were: b. pt. = 99.5°, $d_{\frac{0}{4}} = 0.82263$.

| Pressure in kilograms. | Critical temp of solution. |
|---|---|
| 1 | The triphase system crystallizes at −8°.15 |
| 100 | +5.3 |
| 200 | 17.8 |
| 300 | 24.8 |
| 400 | 30.8 |
| 500 | 36.7 |
| 600 | 42.7 |
| 700 | 49.6 |
| 800 | 58.6 |
| 830 | Homogeneous at all temps |
| 800 | 73 5 |
| 700 | 81.3 |
| 600 | 85.3 |
| 120 | 105.3 |
| 1 | 113.8 |

$C_4H_{10}O_1$

Secondary **BUTYL ALCOHOL** $CH_3.CHOH.CH_2CH_3$.
Iso **BUTYL ALCOHOL** $(CH_3)_2CH.CH_2OH$.

SOLUBILITY OF BUTYL ALCOHOLS IN WATER, "SYNTHETIC METHOD."
(see Note, p. 292)
(Alexejew, 1886.)

| | Secondary Butyl Alcohol and Water. Gms. Secondary Butyl Alcohol per 100 Gms. | | Iso Butyl Alcohol and Water. Gms. Iso Butyl Alcohol per 100 Gms. | |
|---|---|---|---|---|
| t°. | Aqueous Layer. | Alcoholic Layer. | Aqueous Layer. | Alcoholic Layer. |
| −20 | 27 | 66 | ... | ... |
| −10 | 28 | 60 | ... | ... |
| 0 | 27·5 | 56 | 13 | 85 |
| 10 | 26.0 | 57 | ... | ... |
| 20 | 22·5 | 60 | 9 | 84 |
| 30 | 18 | 63·5 | ... | ... |
| 40 | 16 | 65·5 | 7·5 | 83 |
| 60 | 13 | 67 | 7 | 82 |
| 80 | 15 | 63 | 7 | 77·5 |
| 100 | 20 | 52 | 8 | 72 |
| 107 crit. temp. | 33 | | ... | ... |
| 120 | | | 16 | 62 |
| 130 | | | 28 | 50 |
| 133 crit. temp. | | | 49 | |

Additional determinations of the reciprocal solubility of secondary butyl alcohol and water are given by Dolgolenko (1908). This investigator prepared three fractions of 98°–98.6°, 98.6°–99° and 99°–99.5° boiling point respectively, and determined the curve for each fraction and water by the "synthetic method." The first fraction gave a closed curve having both a lower and an upper critical solution temperature, while the other fractions gave curves with only an upper critical solution temperature, and in other respects in fair agreement with the results of Alexejew as shown in the above table. The explanation of this difference in the case of the first fraction, is supposed to be that this fraction contained a larger proportion of tertiary butyl alcohol than the others, due to the lower boiling point of this isomer. Since the tertiary alcohol is entirely miscible with secondary alcohol and water its presence would restrict the boundaries of inhomogeneity and, therefore, tend to favor a closed curve for the system.

SOLUBILITIES, DETERMINED BY THE FREEZING-POINT METHOD ARE GIVEN FOR THE FOLLOWING MIXTURES CONTAINING BUTYL ALCOHOLS.

Isobutyl alcohol + Water (Dreyer, 1913.)
" " + Liquid $CO_2$ (Büchner, 1905–06.)
Normal butyl alcohol + Water (Dreyer, 1913.)
" " " + Liquid $CO_2$ (Büchner, 1905–06.)
Secondary butyl alcohol + Water (Dreyer, 1913; Timmermans, 1907, 1910, 1911.)
" " " + " + Hydroquinine (Timmermans, 1907.)
Tertiary butyl alcohol + Water (Dreyer, 1913.)

100 gms. sat. solution of sec. Butyl Alcohol in Water contain 20 gms. $CH_3CHOHCH_2CH_3$ at 20°.

100 gms. sat. solution of Water in sec. Butyl Alcohol contain 37 gms. $H_2O$ at 20°. (Jones, 1929.)

## Solubility of Iso Butyl Alcohol in Water.

(Jänecke, 1933.)

The determinations were made by the synthetic, sealed tube, method.

| t° | Gms. $(CH_3)_2CH.CH_2OH$ per 100 gms. sat. sol. | t° | Gms. $(CH_3)_2CH.CH_2OH$ per 100 gms. sat. sol. |
|---|---|---|---|
| 28.2 | 8.0 | 130.5 | 20.7 |
| 90.4 | 8.0 | 133 | 26.7 |
| 107.9 | 10.6 | 132.6 | 49.1 |
| 126.7 | 16.3 | 126.4 | 57.8 |
| 127.7 | 17.5 | 38.6 | 81.7 |

Results are also given for the ternary system Iso Butyl Alcohol, Methyl Alcohol and Water. These will be found under Methyl Alcohol.

## Solubility of Iso Butyl Alcohol in Aqueous Solutions of Sodium Benzoate at about 18°.

(Traube, Schoning and Weber, 1927.)

| Normality of Aq. $C_6H_5COONa$ Solution | cc Iso Butyl Alcohol per 5.0 cc sat. solution |
|---|---|
| 0.0 | 0.6 |
| 0.5 | 0.55 |
| 0.75 | 1.05 |
| 0.83 | 1.55 |
| 1.0 | ∞ |

## Distribution of Isobutyl Alcohol between Water and Cotton Seed Oil at 25°. (Wroth and Reid, 1916.)

| Gms. $C_4H_9OH$ per 100 cc. | | | Gms. $C_4H_9OH$ per 100 cc. | | |
|---|---|---|---|---|---|
| Oil Layer. | $H_2O$ Layer. | Ratio. | Oil Layer. | $H_2O$ Layer. | Ratio |
| 1.168 | 2.043 | 1.74 | 1.375 | 2.301 | 1.67 |
| 1.276 | 2.250 | 1.76 | 1.405 | 2.429 | 1.72 |
| 1.288 | 2.135 | 1.65 | 1.495 | 2.450 | 1.64 |

The partition coefficient of tertiary butyl alcohol $(CH_3)_2C(OH)CH_3$, between olive oil and water is given as 0.176 at ord. temp. (Baum, 1899.)

$C_4H_{10}O_1$

Tertiary **BUTYL ALCOHOL** (Tri Methyl Carbinol) $(CH_3)_3COH$.

Freezing-point data for mixtures of Tri methyl Carbinol and Water are given by Paterno and Mieli, 1907.

Freezing-point data are given for mixtures of trimethyl carbinol and the following compounds:

Hydroquinone(1)
α and β Naphthol (1)
α and β Naphthylamine (1)
o and m Phenylene diamine (1)
Pyrogallol (1)
p Dioxane (2)
Pyrocatechol (1)
Resorcinol (1)
p Toluidine (1)
o, m and p Nitrophenol (3)
1, 2, 4 Dinitro phenol (3)
Naphthalene (3)
Phenol (4)
Thymol (4)
Bromo Toluene (4)

(1) Kremann and Wlk, 1919; (2) Getman, 1937; (3) Kremann, Mauermann, Müller II, and Rösler, 1922-23.; (4) Paterno and Ampola, 1897.

**METHYL n PROPYL ETHER** $CH_3OC_3H_7$.
**METHYL Iso PROPYL ETHER** $CH_3OCH_3CHCH_3$.

SOLUBILITY OF METHYL NORMAL PROPYL ETHER AND OF METHYL ISO PROPYL ETHER, EACH SEPARATELY, IN WATER.
(Bennett and Philip, 1928.)

| t° | Gms. n $C_4H_{10}O$ per 100 gms. sat. sol. in water | Gms. iso $C_4H_{10}O$ per 100 gms. sat. sol. in water |
|---|---|---|
| 0 | 5.6 | — |
| 10 | 3.8 | 9.7 |
| 15 | 3.4 | 8.6 |
| 20 | 3.2 | 7.4 |
| 25 | 3.05 | 6.5 |

**ETHYL ETHER** $(C_2H_5)_2O$.

RECIPROCAL SOLUBILITY OF ETHER AND WATER.
(Klobbie — Z. physik. Chem. 24, 619, '97; Schuncke — *Ibid.* 14, 334, '94; St. Tolloczko — *Ibid* 20, 407, 96.)

Solubility of Ether in Water. Lower Layer — Aqueous.

| t°. | Gms. $(C_2H_5)_2O$ per 100 Gms. Water. | Gms. $(C_2H_5)_2O$ per 100 Gms. Solution. |
|---|---|---|
| 0 | 13.12 | 11.6 |
| 5 | 11.4 | 10.2 |
| 10 | 9.5 | 8.7 |
| 15 | 8.2 | 7.6 |
| 20 | 6.95 | 6.5 |
| 25 | 6.05 | 5.7 |
| 30 | 5.4 | 5.1 |
| *40 | 4.7 | 4.5 |
| *50 | 4.3 | 4.1 |
| *60 | 3.8 | 3.7 |
| *70 | 3.3 | 3.2 |
| *80 | 2.9 | 2.8 |

Solubility of Water in Ether. Upper Layer — Ethereal.

| Gms. $H_2O$ per 100 Gms. Ether. | Gms. $H_2O$ per 100 Gms. Solution. |
|---|---|
| 1.01 | 1.0 |
| 1.06 | 1.05 |
| 1.12 | 1.12 (2.6, S.) |
| 1.16 | 1.15 |
| 1.20 | 1.20 (2.65, S.) |
| 1.26 | 1.26 |
| 1.33 | 1.32 |
| 1.52 | 1.50 |
| 1.73 | 1.7 |
| 1.83 | 1 8 |
| 2.04 | 2.0 |
| 2.25 | 2.2 |

* Indicates determinations made by Synthetic Method, for which see page 292.

100 cc. $H_2O$ dissolve 8.11 cc. ether at 22°; vol. of solution, 107.145 cc., Sp. Gr. 0.9853.

100 cc. ether dissolve 2.93 cc. $H_2O$ at 22°; vol. of solution, 103.282 cc.; Sp. Gr. 0.7164. (Herz, 1898.)

More recent determinations of the solubility of ethyl ether in water, agreeing closely with the above data, are given by Osaka, 1910.

Data for the temp.-pressure diagram of ether-water are given by Scheffer, 1912a.

## Reciprocal Solubility of Ether and Water.

(Hill, 1923; Kablukov and Malischeva, 1925.)

A new method for the determination of the reciprocal solubility of liquids was employed by these authors. It depends upon the simple application of the phase rule to the volumes obtained by mixing the two liquids in two different ratios by weight, in two separate experiments at the same temperature. The apparatus consists of flasks with two bulbs of 100 cc. and 300 cc. respectively, having the stem between the bulbs and above the upper bulb, very accurately graduated and calibrated. The method of calculation employed eliminates the correction for change of volume on mixing and enables the solubilities to be calculated directly from the volumetric readings. The flasks were rotated 1/2 hour in a thermostat and allowed to stand 1/2 hour before reading the volume changes.

| | The Solubility of Ether in Water. | | | The Solubility of Water in Ether. | | |
|---|---|---|---|---|---|---|
| | | Gms. Ether per 100 gms. Water layer. | | | Gms. Water per 100 gms. Ether layer. | |
| t°. | Density of Water layer. | Hill. | K and M. | Density of Ether layer. | Hill. | K and M. |
| − 3.83... | − | 12.752 | − (12.2) | − | 0.978 | − |
| 0.0.... | − | 11 668 | − (10.3) | − | 1.078 | − (1.0) |
| 10.0.... | 0.98219 | 9.040 | 9.01 ( 8.3) | 0.72998 | 1.164 | 1.30 |
| 15.0.... | 0.98405 | 7.913 | 7.87 ( 7.0) | 0.72404 | 1.240 | 1.35 (1.1) |
| 20.0.... | 0.98478 | 6.896 | 6.88 ( 6.5) | 0.71835 | 1.264 | 1.45 (1.3) |
| 25.0.... | 0.98508 | 6.027 | 6.04 ( 5.6) | 0.71309 | 1.338 | 1.58 |
| 30.0.... | 0.98505 | 5.340 | 5.34 ( 4.5) | 0.70763 | 1.409 | 1,77 |
| Determinations by other methods are as follows : | | | | | | |
| 15.0.... | 0.985(1) | 7.83(1) | 8.43(2) | 0.722(1) | 1.04(1) | |
| 18.0.... | − | 7.88(3) | 7.80(4) | − | − | |
| 20.0.... | 0.986(1) | 6.89(1) | − | 0.718(1) | 1.10(1) | |
| 25.0.... | 0.987(1) | 6.00(1) | 6.05(2) | 0.714(1) | 1.19(1) | |

(1) Forbes and Coolidge. 1919; (2) Thorne, 1921; (3) Per 100 cc. $H_2O$, Linde, 1917, 1926; (4) Per 100 cc. $H_2O$, von Euler and Svanberg, 1917, 1917 *a*, 1926 The results in parentheses are by Boutin and Sanfourche, 1919.

Later determinations by Bennett and Philip, 1928, using the same method as Hill but reducing the quantities of liquid gave results in very close agreement with those of Hill.

One determination at 20° by Jones, 1929, gave 6.95 gms. $(C_2H_5)_2O$ per 100 gms. aqueous layer and 1.2 gms. $H_2O$ per 100 gms. ether layer.

Determinations of the effect of a third substance ($CdI_2$, $ZnI_2$ and $UO_2(NO_3)_2$) upon the mutual solubility of ethyl ether and water are given by Guempel, 1929.

## Freezing-points of Mixtures of Ethyl Ether and Water.

(Lalande, 1934a.)

The authors results are given in the form of a curve from which the following values were read.

| t° | Gms. $(C_2H_5)_2O$ per 100 gms. mixture | Solid Phase | t° | Gms. $(C_2H_5)_2O$ per 100 gms. mixture | Solid Phase |
|---|---|---|---|---|---|
| -1.0 | 3.8 | Ice | -3.0 | 10.7 | Ice |
| -1.5 | 5.6 | " | -3.5 | 12.2 | " |
| -2.0 | 7.4 | " | -3.78 tr.pt. | 12.8 | " + 2 liquid layers |
| -2.5 | 9.2 | " | | | |

## Solubility of Ether in Aqueous Solutions of Hydrochloric Acid.

(Schuncke — Z. physik. Chem. 14, 334, '94; in 38.52% HCl, Draper — Chem. News, 35, 87, '77.)

| | In 38.52 % HCl. | In 31.61 % HCl. | | | In 20 % HCl. | | |
|---|---|---|---|---|---|---|---|
| t°. | cc. Ether per 100 cc. Solvent. | cc. Ether per 100 cc. Solvent. | Gms. per 1 Gram $H_2O$. HCl. | Gms. per 1 Gram $H_2O$. $(C_2H_5)_2O$. | cc. Ether per 100 cc. Solvent. | Gms. per 1 g. $H_2O$. HCl. | Gms. per 1 g. $H_2O$. $(C_2H_5)_2O$. |
| −6 | 181 | 149 | 0.4622 | 1.387 | 67.2 | 0.253 | 0.5637 |
| 0 | 177.5 | 142 | 0.4622 | 1.308 | 58.3 | 0.253 | 0.4863 |
| +6 | 172.5 | 131.5 | 0.4622 | 1.2075 | 51.1 | 0.253 | 0.4231 |
| 15 | 163 | 121.7 (14°) | 0.4622 | 1.1075 | 40.5 | 0.253 | 0.3299 |
| 20 | 158 | 111.9 (20.8°) | 0.4622 | 1.0005 | 33.1 | 0.253 | 0.2688 |
| 26 | 135 | 104.2 | 0.4622 | 0.9360 | 27.5 | 0.253 | 0.2221 |

| | In 12.58 % HCl. | | | In 3.65 % HCl. | | |
|---|---|---|---|---|---|---|
| t°. | cc. Ether per 100 cc. Solvent. | Gms. per 1 Gram $H_2O$. HCl. | Gms. per 1 Gram $H_2O$. $(C_2H_5)_2O$. | cc. Ether per 100 cc. Solvent. | Gms. per 1 Gram $H_2O$. HCl. | Gms. per 1 Gram $H_2O$. $(C_2H_5)_2O$. |
| −6 | 26.45 | 0.144 | 0.2106 | 19.23 | 0.0308 | 0.1454 |
| 0 | 22.19 | 0.144 | 0.1748 | ... | ... | ... |
| +6 | 19.18 | 0.144 | 0.1503 | 14.31 | 0.0308 | 0.1070 |
| 15 | 15.61 | 0.144 | 0.1210 | 11.83 | 0.0308 | 0.0868 |
| 20 | 13.76 | 0.144 | 0.1059 | 10.52 | 0.0308 | 0.0769 |
| 26 | 12.70 | 0.144 | 0.0970 | 9.24 | 0.0308 | 0.0673 |

The above data are recalculated and discussed by Jüttner, 1901.

## The Binodal Curve of the System Ethyl Ether Phosphoric Acid and Water at 0°.

(Ousti - Katchincev and Klebnikov, 1939.)

| Gms. per 100 gms. sat. sol. | | | Gms. per 100 gms. sat. sol. | | |
|---|---|---|---|---|---|
| $H_3PO_4$ | $(C_2H_5)_2O$ | $H_2O$ | $H_3PO_4$ | $(C_2H_5)_2O$ | $H_2O$ |
| 0.0 | 11.7 | 88.3 | 40.1 | 27.8 | 32.1 |
| 14.1 | 9.4 | 76.5 | 33.3 | 47.0 | 19.7 |
| 24.4 | 10.1 | 64.5 | 23.3 | 70.0 | 6.7 |
| 36.3 | 16.4 | 47.3 | 9.4 | 85.0 | 5.6 |
| 39.2 | 19.6 | 41.2 | | | |

Data for locating three tie lines are also given.

Freezing-point data for mixtures of $(C_2H_5)_2O + H_3PO_4$ are given by Rabinowitsch and Jakubsohn, 1923.

Freezing-point data for the systems $(C_2H_5)_2O.HBr + H_2O$ and $(C_2H_5)_2O.HBr + C_2H_5OH$ are given by Maass and Russel, 1919.

## Solubility of Ethyl Ether in Aqueous Solutions of Acids.

(Marie and Lejeune, 1929.)

| t° | Acid | Gm. Mols. Acid per liter of solution | Gms. $(C_2H_5)_2O$ per 10 cc acid solution | t° | Acid | Gm. Mols. Acid per liter of solution | Gms. $(C_2H_5)_2O$ per 10 cc acid solution |
|---|---|---|---|---|---|---|---|
| 18 | $HClO_4$ | 1.78 | 3.54 | 25 | HCl | 5.65 | 2.4 |
| " | " | 3.05 | 11.0 | " | " | 7.50 | 5.1 |
| " | " | 4.07 | 21.2 | " | " | 10.45 | 9.6 |
| " | " | 5.10 | 35.8 | 18 | $H_2SO_4$ | 5.92 | 1.9 |
| " | " | 7.82 | 56.5 | " | " | 6.50 | 3.0 |
| " | " | 9.50 | 47.5 | " | " | 8.15 | 6.75 |
| 25 | " | 2.50 | 4.25 | " | " | 8.75 | 8.60 |
| " | " | 3.55 | 11.8 | " | " | 9.05 | 10.0 |
| " | " | 3.98 | 16.5 | 25 | " | 6.22 | 2.0 |
| " | " | 4.70 | 25.2 | " | " | 6.80 | 3.2 |
| " | " | 5.20 | 31.25 | " | " | 8.15 | 6.4 |
| " | " | 5.60 | 37.7 | " | " | 9.25 | 9.35 |
| " | " | 5.96 | 44.2 | 18 | $H_3PO_4$ | 7.6 | 3.1 |
| " | " | 7.36 | 47.0 | " | " | 8.58 | 7.3 |
| " | " | 10.25 | 44.2 | " | " | 10.10 | 12.6 |
| 18 | HCl | 5.40 | 2.24 | 25 | " | 7.75 | 2.3 |
| " | " | 6.90 | 4.84 | " | " | 8.60 | 5.55 |
| " | " | 10.0 | 9.55 | " | " | 10.3 | 10.60 |

## The Binodal Curve of the System Ethyl Ether Sulfuric Acid and Water.

(Ousti-Katchincev and Klebnikov, 1939.

Results at -10

| Gms. per 100 gms. sat. sol. | |
|---|---|
| $H_2SO_4$ | $(C_2H_5)_2O$ |
| 0.0 | 14.3 |
| 14.2 | 8.1 |
| 19.6 | 8.8 |
| 27.4 | 14.9 |
| 31.7 | 24.0 |
| 32.5 | 34.9 |
| 33.2 | 38.0 |
| 27.3 | 64.2 |
| 18.5 | 76.2 |

Results at 0

| Gms. per 100 gms. sat. sol. | |
|---|---|
| $H_2SO_4$ | $(C_2H_5)_2O$ |
| 0.0 | 11.7 |
| 7.5 | 7.4 |
| 16.3 | 5.2 |
| 21.2 | 6.1 |
| 33.3 | 14.9 |
| 35.0 | 32.4 |
| 31.0 | 49.1 |
| 26.1 | 68.3 |
| 9.2 | 90.2 |

Results at 20°

| Gms. per 100 gms. sat. sol. | |
|---|---|
| $H_2SO_4$ | $(C_2H_5)_2O$ |
| 0.0 | 7.4 |
| 6.3 | 5.1 |
| 14.2 | 4.7 |
| 20.6 | 5.3 |
| 34.4 | 7.3 |
| 37.8 | 11.5 |
| 43.4 | 21.8 |
| 44.0 | 35.3 |
| 38.2 | 59.0 |
| 18.4 | 78.3 |

Data for locating three tie lines at 0° are also given.

## Solubility of Ethyl Ether in Aq. Sulfuric Acid at 0°.

(Kremann, 1910a.)

| Gms. per 100 Gms. Homogeneous Mixture. | | |
|---|---|---|
| $(C_2H_5)_2O$. | $H_2O$. | $H_2SO_4$. |
| 24.2 | 34.5 | 41.3 |
| 24.8 | 35.4 | 39.8 |
| 43.9 | 15.7 | 40.4 |
| 34 | 26.1 | 39.9 |

| Gms. per 100 Gms. Homogeneous Mixture. | | |
|---|---|---|
| $(C_2H_5)_2O$. | $H_2O$. | $H_2SO_4$. |
| 16.1 | 42.7 | 41.2 |
| 6.1 | 78 | 15.9 |
| 53.8 | 8.5 | 37.7 |

Data for the system ethyl ether, ethyl alcohol, water, sulfuric acid at 0° are also given.

Data showing the influence of Cadmium Iodide upon the mutual solubility of Ethyl Ether and Water are given by Guempel, 1929. This author also gives complete data for the system Ethyl Ether + $H_2O$ + $CdI_2$. Similar data are also given for the systems Ethyl Ether + $H_2O$ + $ZnI_2$ and for Ethyl Ether + $H_2O$ + $UO_2(NO_3)_2$.

Data for the solubility of ethyl ether in carbon dioxide at high pressures are given by Sander (1911–12). The determinations were made by using quite small amounts of ether and observing the pressure at which a drop of liquid just appeared or disappeared in a mixture of known weight per cent composition. The results give the "gas curve" for constant temperature and when plotted in connection with the "liquid curve" (see VOL I p. 234), give the complete pressure — concentration diagram.

Freezing-point lowering data for mixtures of ethyl ether and hydrochloric acid are given by Maass and McIntosh (1913).

SOLUBILITY OF ETHER IN AQUEOUS SALT, ETC., SOLUTIONS AT 18°.

(Euler, 1904.)

| Aq. Solution of: | Gm. per Liter Added Salt. | Gms. $(C_2H_5)_2O$ per 100 cc. Solvent. | Aq. Solution of: | Gms. per Liter Added Salt. | Gms. $(C_2H_5)_2O$ per 100 cc. Solvent. |
|---|---|---|---|---|---|
| Water | 0 | 7.8 | $Na_2SO_4$ | 59.54 | 3.7 |
| $KNO_3$ | 101.19 | 5.4 | Mannite | 91.06 | 6.7 |
| KCl | 73.6 | 4.7 | $H_2SO_4$ | 49 | 6.6 |
| LiCl | 42.48 | 5.2 | " | 122.5 | 5.65 |
| NaCl | 58.5 | 4.5 | " | 245. | 4.55 |

SOLUBILITY OF ETHYL ETHER IN AQ. SALT SOLUTIONS AT 28°.

(Thorin, 1915.)

| Solvent. | Gms. $(C_2H_5)_2O$ per 100 cc. Solvent. | Solvent. | Gms. $(C_2H_5)_2O$ per 100 cc. Solvent. | Solvent. | Gms. $(C_2H_5)_2O$ per 100 cc. Solvent. |
|---|---|---|---|---|---|
| Water | 5.85 | 0.5 *n* $Na_3PO_4$ | 4.17 | 0.5 *n* Na Succinate | 4.68 |
| 0.5 *n* NaI | 5.70 | 0.5 *n* $Na_3AsO_4$ | 4.20 | 0.5 *n* Na Citrate | 4.19 |
| 0.5 *n* NaBr | 4.68 | 0.5 *n* $Hg(CN)_2$ | 5.71 | 0.5 *n* Na Acetate | 4.15 |
| 0.5 *n* NaCl | 4.48 | 0.5 *n* $NH_4NO_3$ | 5.37 | 0.5 *n* Na Tartrate | 4.12 |
| 0.5 *n* NaF | 4.15 | 0.5 *n* $FeCl_3$ | 5.09 | 0.5 *n* Na Phthalate | 5.88 |
| 0.5 *n* $Na_2SO_4$ | 4.30 | 0.5 *n* $Na_2Cr_2O_7$ | 4.84 | 0.5 *n* Na Cinnamate | 6.29 |
| 0.5 *n* $Na_2CrO_4$ | 4.22 | 0.5 *n* $FeSO_4$ | 4.33 | 0.5 *n* Na Benzoate | 5.99 |
| 0.5 *n* $Na_2MoO_4$ | 4.39 | 0.5 *n* $Al_2(SO_4)_3$ | 3.95 | 0.5 *n* Na Salicylate | 6.44 |
| 0.5 *n* $Na_2WO_4$ | 4.12 | 0.5 *n* Am. Oxalate | 4.74 | 0.5 *n* Na Benzene Sulfonate | 6.05 |

SOLUBILITY OF ETHYL ETHER IN 0.91 PER CENT (PHYSIOLOGICAL NORMAL SALINE) AQUEOUS NaCl SOLUTION.

(Bennett, 1912.)

Determinations made by freezing-point method. Ether of $d_{15} = 0.720$ used

| t°. | Gms. $(C_2H_5)_2O$ per 100 Gms. Aq. NaCl. | cc. $(C_2H_5)_2O$ (at 15°) per 100 cc. Aq. NaCl. |
|---|---|---|
| 0 | 13.08 | 18.27 |
| 5 | 11.15 | 15.58 |
| 10 | 9.45 | 13.20 |
| 15 | 8.10 | 11.31 |
| 20 | 6.87 | 9.60 |
| 25 | 5.96 | 8.33 |
| 30 | 5.30 | 7.40 |

Purified ether prepared from methylated spirit gave slightly higher results.

### Solubility of Ether in Aqueous Solutions of Sodium Chloride. (Thorne, 1921.)

The solutions were saturated by constant shaking for 3 1/2 to 4 hours.
The ether was determined by passing a current of dry air through a weighed amount of the saturated solution and calculating from the observed loss in weight.

Results at 15°.

| Gms. per 100 gms. sat. sol. | |
|---|---|
| NaCl. | $(C_2H_5)_2O$. |
| 0.0 | 8.43 |
| 0.91 | 8.10 |
| 1.033 | 7.73 |
| 2.30 | 6 67 |
| 3.307 | 5.81 |
| 5.881 | 4.37 |
| 7.108 | 3.91 |

| Gms per 100 gms. sat. sol. | |
|---|---|
| NaCl. | $C_2H_5)_2O$. |
| 8.75 | 3.20 |
| 11.08 | 2.32 |
| 14.16 | 1.55 |
| 16.24 | 1.11 |
| 21.58 | 0.577 |
| 23.18 | 0.454 |
| 26.52 | 0.309 |

Results at 25°.

| Gms. per 100 gms. sat. sol. | |
|---|---|
| NaCl. | $(C_2H_5)_2O$. |
| 0.0 | 6.05 |
| 0.91 | 5.96 |
| 2.837 | 4.78 |
| 5.970 | 3.41 |
| 7.812 | 2.57 |
| 11.08 | 1.88 |
| 15.79 | 0.979 |
| 21.18 | 0.463 |
| 24.90 | 0.309 |

The following results at 18° were obtained by Linde, 1917. 1926.

| Gm mols. NaCl per liter... | 0.0. | 0.1. | 0.2. | 0.3. | 0.4. | 0.5. | 0.6. | 0.8. | 1.0. |
|---|---|---|---|---|---|---|---|---|---|
| Gms $(C_2H_5)_2O$ per 100 cc. solvent... | 7.88 | 7.66 | 7.20 | 6.84 | 6.48 | 6.12 | 5.78 | 5.19 | 4.62 |

von Euler and Svanberg, 1917, 1917 *a*, 1926, found 4 5 gms. $(C_2H_5)_2O$ per 100 cc. of aq. 1.0 normal Na Cl at 18°.

### Solubility of Ether in Aqueous Solutions at 18°. (Linde, 1917, 1926.)

The determinations were made by rotating together in a sealed flask at 18°, 50 cc. of the solvent and such volumes of ether, that, after the period of rotation, not more than 0.5 cc. remained undissolved. The weight of dissolved ether was found by multiplying the volume by the $d_{18} = 0.716$.

| Aqueous solvent. | Gms. $(C_2H_5)_2O$ per 100 cc. solvent. |
|---|---|
| 0.1 *n* $CH_3COONa$ .. ..... | 7.22 |
| 0.2 » ..... | 6.70 |
| 0.3 » ..... | 6.14 |
| 0.4 » ..... | 5.58 |
| 0.5 » ..... | 5.14 |
| 0.6 » ..... | 4.73 |
| 0.7 » ..... | 4.33 |
| 0.8 » ... ..... | 4.06 |
| 1.0 » ..... ..... | 3.44 |
| 0.1 *n* Sodium picrate ..... | 8.16 |
| 0.5 » phenolate..... | 5.59 |
| 0.5 » lactate..... | 6.30 |
| 0.25 » maleate..... | 7.21 |
| 0.75 *n* NaCl + 0.25 *n* $CH_3COONa$. | 4.37 |
| 0.5 » + 0.5 » ..... | 4.00 |
| 0.25 » + 0.75 » ..... | 3.65 |

| Aqueous solvent. | Gms. $(C_2H_5)_2O$ per 100 cc. solvent. |
|---|---|
| 0.5 *n* $Na_2SO_4$ | 5.52 |
| 0.375 » + 0.125 *n* $H_2SO_4$.. | 5.98 |
| 0.333 » + 0.166 » ..... | 6.16 |
| 0.3125 » + 0.1875 » ..... | 6.30 |
| 0.28125 » + 0.218-5 » ..... | 6.45 |
| 0.2 » + 0.25 » ..... | 6.51 |
| 0 1875 » + 0.3125 » ... . | 6.81 |
| 0.125 » + 0.375 » ..... | 7.09 |
| 0.0625 » + 0.4375 » ..... | 7.26 |
| 0.000 » + 0.5 » ..... | 7.56 |
| 0.5 » ..... | 5.50 |
| 0.425 » + 0.075 *n* NaOH.... | 5.53 |
| 0.375 » + 0.125 » ..... | 5.55 |
| 0.25 » + 0.25 » ..... | 5.50 |
| 0.125 » + 0.375 » ..... | 5.55 |
| 0.00 » + 0.500 » ..... | 5.56 |

von Euler and Svanberg, 1917, 1917 *a*, 1926, found 3.7 gms. $(C_2H_5)_2O$ per 100 cc. of 1.0 *n* $CH_3CO\,O\,Na$ at 18° and 3.7 gms. $(C_2H_5)_2O$ per 100 cc. of 1.0 *n* $Na_2SO_4$ at 18°.

Data for the reciprocal solubility of ether and water at 15°, 20° and 25°, in solutions respectively saturated with succinic acid, are given by Forbes and Coolidge, 1919.

Data for the solubility of mixtures of ethyl ether and kerosene and of ethyl ether and xylene in 92 wt. per cent ethyl alcohol at 20° are given by Ormandy and Craven, 1921

FREEZING-POINTS OF MIXTURES OF BENZENE AND ETHYL ETHER.
(Yamamura, 1926.)

| t° of freezing. | Mol. per cent $C_6H_6$ in mixture. | t° of freezing. | Mol. per cent $C_6H_6$ in mixture. | t° of freezing. | Mol. per cent $C_6H_6$ in mixture. |
|---|---|---|---|---|---|
| 5.1 | 109.0 | —33.0 | 50.4 | — 94.0 | 12.3 |
| 1.7 | 94.9 | —36.9 | 45.0 | —105.0 | 9.6 |
| 0.4 | 93.0 | —43.4 | 40.4 | —106.0 | 8.7 |
| — 4.3 | 85.1 | —48.0 | 35.9 | —115.5 | 7.6 |
| — 4.8 | 84.0 | —52.5 | 30.3 | —118.5 | 7.3 |
| —11.2 | 74.9 | —61.3 | 25.5 | —126.5 | 5.2 |
| —14.9 | 69.4 | —71.7 | 19.7 | —126.5 | 5.1 |
| —18.6 | 64.9 | —74.5 | 18.0 | —125.0 | 2.9 |
| —22.6 | 60.5 | —79.0 | 17.7 | —124.5 | 2.4 |
| —27.0 | 55.1 | —88.5 | 14.9 | —123.5 | 0.0 = unstable form of $(C_2H_5)_2O$ |

Results for the total and partial vapor pressures at 20.5° in mixtures of ethyl ether and each of the following compounds: acetonitrile, nitro methane, allyl iso sulfocyanate and tri ethyl amine, are given by Joukovsky, 1934.

Freezing-point data are given for mixtures of Ethyl Ether and each of the following compounds:

Acetic Acid (Pickering, 1893.)
Trichloro Acetic Acid (Tsakalotos and Nitro Benzene Guye, 1910)
Carbon Disulfide (Saphir, 1929.)
Methyl Alcohol " "
Acetone " (Waddell, 1899.)
Iso Pentane "
Ethyl Alcohol "
" " (Lalande, 1933.)
Formamide (Joukovsky, 1934.)
Carbon Tetra Chloride (Wyatt, 1929.)
Chloroform " "
Aniline (Timmermans, 1930.)
Ethylol " 1934.
Methylol " "
Ethylene Chloride (Huettig, 1935.)
Ethyl Iodide (Wroczynsky and Guye, 1910.)

## ERYTHRITOL $(CH_2OH.CHOH)_2$.

SOLUBILITY OF ERYTHRITOL IN WATER DETERMINED BY THE FREEZING-POINT METHOD. (Pushin and Glagoleva, 1922.)

| t° of cryst. | Mol. per cent $(CH_2OH.CHOH)_2$. | Solid Phase. | t° of cryst. | Mol. per cent $(CH_2OH.CHOH)_2$. | Solid Phase. |
|---|---|---|---|---|---|
| — 1.1.. | 0.9 | Ice | 65.0.. | 26.1 | $(CH_2OH.CHOH)_2$ |
| — 2.4.. | 2.0 | » | 70.5.. | 29.0 | » |
| — 3.1.. | 2.5 | » | 76.2.. | 33.3 | » |
| — 4.4.. | 3.0 | »+$(CH_2OH.CHOH)_2$ | 82.0.. | 39.8 | » |
| — 1.0.. | 4.8 | $(CH_2OH.CHOH)_2$ | 87.8.. | 42.4 | » |
| —14.0.. | 7.0 | » | 97.5.. | 56.4 | » |
| 22.8.. | 9.0 | » | 102.5.. | 65.7 | » |
| 27.4.. | 11.1 | » | 106.5.. | 75.2 | » |
| 36.5.. | 13.4 | » | 110.2.. | 80.0 | » |
| 40.4.. | 14.4 | » | 114.0.. | 92.4 | » |
| 54.6.. | 17.5 | » | 116.6.. | 100.0 | » |

100 gms. $H_2O$ dissolve 61.5 gms. erythritol at 20–25°. (Dehn, 1917.)
100 gms. aq. 50% pyridine dissolve 8.47 gms. erythritol at 20–25°. "
100 gms. pyridine dissolve 2.50 + gms. erythritol at 20–25. (Dehn, 1917; Holty, 1905.)

Freezing-point data are given by Puschin and Dezelic, 1932, for mixtures of Erythritol and each of the following compounds:
Antimony tri bromide, Mono chloro acetic acid, Tri chloro acetic acid, Benzoic acid, Cinnamic acid, Elaidinic acid, Mannite, Oleic acid, Palmitic acid, Phenol, 2.4.6 Tri nitro Phenol, o and p Phenylene diamine, Resorcinol, Stearic acid, Urea, and Urethan.

**DI ETHYL AMINE** $NH(C_2H_5)_2$.

SOLUBILITY OF DI ETHYL AMINE IN WATER, DETERMINED BY THE SYNTHETIC METHOD.
(Lattey, 1905.)

| t° | Gms. $NH(C_2H_5)_2$ per 100 gms. $H_2O$ layer | Amine layer | t° | Gms. $NH(C_2H_5)_2$ per 100 gms. $H_2O$ layer | Amine layer |
|---|---|---|---|---|---|
| 155 | 21.7 | 59.0 | 145 | 28.0 | 49.0 |
| 150 | 23.6 | 55.5 | 144 | 31.0 | 45.0 |
| 148 | 24.8 | 53.5 | 143.5 (Crit. t.) | 37.4 | |
| 146 | 26.3 | 51.0 | | | |

The solubility of Di Ethyl Amine in Water at 60°, calculated from the vapor pressures, determined by an aspiration method, is given by Doyer, 1890, as 89 in terms of the Ostwald Solubility Expression and 73 in terms of the Bunsen Absorption Coefficient at a vapor pressure of 233 mm Hg.

Freezing-point data for mixtures of Di ethyl amine and Water are given by Guthrie, 1884, and Pickering, 1893.

**DIETHYL AMINE** Hydrobromide, Hydrochloride and Hydroiodide.

SOLUBILITY OF EACH SEPARATELY IN WATER AND IN CHLOROFORM AT 25°.
(Peddle and Turner, 1913.)

| Compound | Formula | Gms. Compound per 100 gms. $H_2O$ | Gms. Compound per 100 gms. $CHCl_3$ |
|---|---|---|---|
| Diethyl Amine Hydrobromide | $(C_2H_5)_2NH.HBr$ | 311.6 | 46.65 |
| " " Hydrochloride | $(C_2H_5)_2NH.HCl$ | 231.7 | 29.45 |
| " " Hydroiodide | $(C_2H_5)_2NH.HI$ | 377.2 | 71.56 |

DISTRIBUTION OF DIETHYL AMINE AT 25° BETWEEN : (Smith, 1921-1922.)

Water and Amyl Alcohol.

| Millimols. $(C_2H_5)_2NH$ per liter | | |
|---|---|---|
| $H_2O$ layer ($C_1$). | $CH_3(CH_2)_3CH_2OH$ layer ($C_2$). | $\frac{C_2}{C_1}$. |
| 0.65 | 1.625 | 2.52 |
| 1.05 | 2.9625 | 2.82 |
| 1.675 | 5.450 | 3.26 |
| 2.875 | 10.625 | 3.70 |
| 4.95 | 20.00 | 4.04 |

Water and *n* Butyl Alcohol.

| Millimols. $(C_2H_5)_2NH$ per liter | | |
|---|---|---|
| $H_2O$ layer ($C_1$). | $CH_3.(CH_2)_2CH_2OH$ layer ($C_2$). | $\frac{C_2}{C_1}$. |
| 0.275 | 0.575 | 2.09 |
| 0.675 | 1.540 | 2.30 |
| 1.35 | 3.175 | 2.35 |
| 2.50 | 6.8 | 2.72 |

Water and Isobutyl Alcohol

| Millimols. $(C_2H_5)_2NH$ per liter | | |
|---|---|---|
| $H_2O$ layer ($C_1$). | $(CH_3)_2CH.CH_2OH$ layer ($C_2$). | $\frac{C_2}{C_1}$. |
| 0.300 | 0.625 | 2.08 |
| 0.550 | 1.225 | 2.22 |
| 0.650 | 1.500 | 2.3 |
| 1.0875 | 2.6125 | 2.4 |

DISTRIBUTION OF DIETHYL AMINE AT 25° BETWEEN : (Smith, 1921-1922.)

Water and Xylene.

| Millimols. $(C_2H_5)_2NH$ per liter | | |
|---|---|---|
| $H_2O$ layer ($C_1$). | $C_6H_4(CH_3)_2$ layer ($C_2$). | $\frac{C_2}{C_1}$. |
| 1.44 | 0.55 | 0.38 |
| 2.72 | 1.28 | 0.47 |
| 4.075 | 1.925 | 0.472 |
| 6.45 | 3.55 | 0.552 |
| 12.68 | 7.42 | 0.59 |

Acetone and Glycerol.

| Millimols. $(C_2H_5)_2NH$ per liter | | |
|---|---|---|
| Acetone layer (A). | Glycerol layer (G). | $\frac{A}{G}$. |
| 0.625 | 1.75 | 0.357 |
| 1.75 | 3.375 | 0.518 |
| 4.70 | 6.775 | 0.693 |
| 4.50 | 6.55 | 0.687 |
| 15.80 | 18.10 | 0.873 |

## Distribution of Diethyl Amine at 25° Between.

(Smith, 1921-1922,)

### Water and *sec.* Octyl Alcohol.

| Millimols. $(C_2H_5)_2NH$ per liter | | |
|---|---|---|
| $H_2O$ layer ($C_1$). | $CH_3(CH_2)_5CHOH.CH_3$ layer ($C_2$). | $\frac{C_2}{C_1}$. |
| 0.475 | 0.50 | 1.05 |
| 1.05 | 1.20 | 1.14 |
| 1.75 | 2.01 | 1.16 |
| 2.10 | 2.50 | 1.19 |

### Water and *n* Butyl Bromide.

| Millimols. $(C_2H_5)_2NH$ per liter | | |
|---|---|---|
| $H_2O$ layer ($C_1$). | $CH_3(CH_2)_3Br$ layer ($C_2$). | $\frac{C_2}{C_1}$. |
| 1.10 | 0.725 | 0.660 |
| 2.10 | 1.3375 | 0.637 |
| 3.475 | 2.20 | 0.633 |
| 6.60 | 4.00 | 0.606 |

### Water and *n* Butyl Ether

| Millimols. $(C_2H_5)_2NH$ per liter | | |
|---|---|---|
| $H_2O$ layer ($C_1$). | $(C_4H_9)_2O$ layer ($C_2$). | $\frac{C_2}{C_1}$. |
| 0.925 | 0.625 | 0.676 |
| 2.1625 | 1.375 | 0.632 |
| 4.05 | 2.45 | 0.605 |
| 7.75 | 4.55 | 0.587 |

### Water and Benzene.

| Millimols. $(C_2H_5)_2NH$ per liter | | |
|---|---|---|
| $H_2O$ layer ($C_1$). | $C_6H_6$ layer ($C_2$). | $\frac{C_2}{C_1}$. |
| 2.1375 | 1.2375 | 0.578 |
| 3.875 | 2.475 | 0.638 |
| 6.575 | 4.35 | 0.662 |
| 11.95 | 9.05 | 0.756 |
| 22.30 | 18.30 | 0.822 |

### Water and Brombenzene.

| Millimols. $(C_2H_5)_2NH$ per liter | | |
|---|---|---|
| $H_2O$ layer ($C_1$). | $C_6H_5Br$ layer ($C_2$). | $\frac{C_2}{C_1}$. |
| 1.100 | 0.625 | 0.568 |
| 1.4625 | 0.8875 | 0.607 |
| 2.1875 | 1.1375 | 0.520 |
| 3.40 | 1.70 | 0.50 |
| 3.825 | 2.075 | 0.542 |
| 7.15 | 4.05 | 0.567 |

### Water and *o* Dichlorbenzene.

| Millimols. $(C_2H_5)_2NH$ per liter | | |
|---|---|---|
| $H_2O$ layer ($C_1$). | *o* $C_6H_4Cl_2$ layer ($C_2$). | $\frac{C_2}{C_1}$. |
| 1.475 | 0.95 | 0.643 |
| 1.55 | 1.075 | 0.693 |
| 3.175 | 2.325 | 0.732 |
| 5.50 | 3.30 | 0.60 |
| 11.70 | 7.15 | 0.61 |

### Water and 1.3.4 Trichlorbenzene.

| Millimols $(C_2H_5)_2NH$ per liter | | |
|---|---|---|
| $H_2O$ layer ($C_1$). | 1.3.4.$C_6H_3Cl_3$ layer ($C_2$). | $\frac{C_2}{C_1}$. |
| 1.4375 | 0.4125 | 0.287 |
| 3.325 | 1.125 | 0.346 |
| 4.95 | 1.925 | 0.403 |
| 9.45 | 4.05 | 0.43 |

### Water and Carbon Tetrachloride.

| Millimols. $(C_2H_5)_2NH$ per liter | | |
|---|---|---|
| $H_2O$ layer ($C_1$). | $CCl_4$ layer ($C_2$). | $\frac{C_2}{C_1}$. |
| 1.425 | 0.850 | 0.597 |
| 2.525 | 1.9375 | 0.700 |
| 5.075 | 4.00 | 0.788 |
| 7.80 | 7.00 | 0.897 |

### Water and Chloroform.

| Millimols. $(C_2H_5)_2NH$ per liter | | |
|---|---|---|
| $H_2O$ layer ($C_1$). | $CHCl_3$ layer ($C_2$). | $\frac{C_2}{C_1}$. |
| 0.300 | 0.600 | 2.00 |
| 0.800 | 2.000 | 2.50 |
| 1.625 | 5.025 | 3.09 |
| 4.350 | 17.95 | 4.13 |

### Water and Ethyl Ether.

| Millimols. $(C_2H_5)_2NH$ per liter | | |
|---|---|---|
| $H_2O$ layer ($C_1$). | $(C_2H_5)_2O$ layer ($C_2$). | $\frac{C_2}{C_1}$. |
| 0.6125 | 0.4375 | 0.714 |
| 1.100 | 0.7375 | 0.671 |
| 1.650 | 1.075 | 0.652 |
| 2.875 | 2.025 | 0.704 |
| 7.90 | 6.30 | 0.798 |

### Water and Iso Amyl Phenyl Ether.

| Millimols. $(C_2H_5)_2NH$ per liter | | |
|---|---|---|
| $H_2O$ layer ($C_1$). | $C_5H_{11}.O.C_6H_5$ layer ($C_2$). | $\frac{C_2}{C_1}$. |
| 1.85 | 0.815 | 0.440 |
| 3.30 | 1.35 | 0.410 |
| 5.775 | 2.55 | 0.442 |
| 9.50 | 3.90 | 0.411 |

### Water and Ethylene Chloride.

| Millimols. $(C_2H_5)_2NH$ per liter | | |
|---|---|---|
| $H_2O$ layer ($C_1$). | $CH_2Cl.CH_2Cl$ layer ($C_2$). | $\frac{C_2}{C_1}$. |
| 0.95 | 0.835 | 0.880 |
| 1.875 | 1.05 | 0.886 |
| 2.15 | 1.925 | 0.886 |
| 4.475 | 4.075 | 0.910 |

### Water and Paraffine oil.

| Millimols. $(C_2H_5)_2NH$ per liter | | |
|---|---|---|
| $H_2O$ layer ($C_1$). | Paraffine oil layer ($C_2$). | $\frac{C_2}{C_1}$. |
| 1.475 | 0.300 | 0.204 |
| 3.20 | 0.575 | 0.180 |
| 3.35 | 0.650 | 0.194 |
| 5.25 | 1.025 | 0.192 |
| 8.70 | 1.40 | 0.161 |
| 8.80 | 1.50 | 0.170 |
| 16.10 | 3.00 | 0.186 |

### Water and Petroleum (b. pt. 145-155°) = Nonane.

| Millimols. $(C_2H_5)_2NH$ per liter | | |
|---|---|---|
| $H_2O$ layer ($C_1$). | Petroleum layer ($C_2$). | $\frac{C_2}{C_1}$. |
| 2.7125 | 0.850 | 0.313 |
| 4.175 | 1.275 | 0.305 |
| 0.442 | 1.30 | 0.289 |
| 4.825 | 1.425 | 0.295 |
| 7.25 | 2.05 | 0.283 |
| 11.35 | 3.25 | 0.287 |

### Distribution of Diethyl Amine at 25° Between:
(Herz and Stanner, 1927.)

| Water and Benzene | | | Water and Toluene | | | Water and Ethyl Benzene | | |
|---|---|---|---|---|---|---|---|---|
| Gm. Mols. $(C_2H_5)_2NH$ per liter | | 2/1 | Gm. Mols. $(C_2H_5)_2NH$ per liter | | 2/1 | Gm. Mols. $(C_2H_5)_2NH$ per liter | | 2/1 |
| $H_2O$ layer(1) | $C_6H_6$ layer(2) | | $H_2O$ layer(1) | $C_6H_5CH_3$ layer(2) | | $H_2O$ layer(1) | $C_6H_5C_2H_5$ layer(2) | |
| 0.0726 | 0.0653 | 0.899 | 0.0979 | 0.0734 | 0.750 | 0.1180 | 0.0787 | 0.667 |
| 0.1387 | 0.1326 | 0.956 | 0.1787 | 0.1469 | 0.822 | 0.1311 | 0.0853 | 0.650 |
| 0.1979 | 0.1877 | 0.948 | 0.3427 | 0.2733 | 0.798 | 0.2295 | 0.1574 | 0.686 |
| 0.2652 | 0.2501 | 0.943 | 0.6181 | 0.5357 | 0.867 | | | |

### Distribution of Diethyl Amine Between Water and Toluene.
(Moore and Winmill, 1912.)

| t° | Gm. Equiv. $(C_2H_5)_2NH$ per liter $H_2O$ layer | Dist. Coef. | t° | Gm. Equiv. $(C_2H_5)_2NH$ per liter $H_2O$ layer | Dist. Coef. |
|---|---|---|---|---|---|
| 18 | 0.0484 | 2.14 | 25 | 0.0416 | 1.59 |
| " | 0.0503 | 2.14 | 32.35 | 0.1200 | 1.093 |
| 25 | 0.0483 | 1.59 | " | 0.1104 | 1.095 |

### Distribution of Diethyl Amine at 25° Between Methyl Alcohol and Vaseline.
(Kozakewitch, 1935.)

| Gm. Mols. $(C_2H_5)_2NH$ per 1000 gms.: | | 1/2 |
|---|---|---|
| $CH_3OH$ layer(1) | Vaseline layer(2) | |
| 0.253 | 0.0115 | 22.0 |
| 0.273 | 0.0103 | 26.5 |
| 0.527 | 0.0182 | 29.1 |
| 0.806 | 0.0296 | 27.2 |

Several determinations are also given showing the effect of additions of lithium chloride upon the above distribution.

## BUTYL AMINE (Normal) $CH_3(CH_2)_2CH_2NH_2$.

### Distribution of Normal Butyl Amine at 25° Between: (Smith, 1921-1922.)

Water and Ethyl Ether.

| Millimols. $CH_3(CH_2)_2CH_2NH_2$ per liter of | | $\frac{C_2}{C_1}$. |
|---|---|---|
| $H_2O$ layer ($C_1$). | $(C_2H_5)_2O$ layer ($C_2$). | |
| 0.85 | 0.76 | 0.895 |
| 1.35 | 1.23 | 0.912 |
| 2.15 | 2.20 | 1.02 |
| 3.20 | 3.52 | 1.10 |

Water and Xylene.

| Millimols. $CH_3(CH_2)_2CH_2NH_2$ per liter of | | $\frac{C_2}{C_1}$. |
|---|---|---|
| $H_2O$ layer ($C_1$). | $C_6H_4(CH_3)_2$ layer ($C_2$). | |
| 0.671 | 0.328 | 0.490 |
| 1.28 | 0.718 | 0.560 |
| 2.40 | 1.50 | 0.665 |
| 5.60 | 4.40 | 0.785 |

DISTRIBUTION AT 25° OF : (Smith, 1921-1922.)

Iso Butyl amine $(CH_3)_2CH.CH_2NH_2$, Between Water and Xylene.

| Millimols. $(CH_3)_2CH.CH_2NH_2$ per liter of | | |
|---|---|---|
| $H_2O$ layer ($C_1$). | $C_6H_4(CH_3)_2$ layer ($C_2$). | $\frac{C_2}{C_1}$. |
| 0.625 | 0.362 | 0.58 |
| 1.775 | 0.975 | 0.55 |
| 3.575 | 2.075 | 0.58 |

Di *iso* Butyl Amine Acid Phthalate*, Between Acetone and Glycerol.

| Millimols. Acid Phthalate per liter of | | |
|---|---|---|
| Glycerol layer (G). | Acetone layer (A). | $\frac{A}{G}$. |
| 1.90 | 1.10 | 0.580 |
| 3.95 | 2.10 | 0.530 |
| 5.85 | 3.10 | 0.530 |
| 7.60 | 3.80 | 0.500 |
| 9.65 | 4.45 | 0.462 |

**IsoBUTYLAMINE HYDROCHLORIDE** $(CH_3)_2CHCH_2NH_2.HCl$.

100 gms. $H_2O$ dissolve 238.9 gms. of the salt at 25°. (Peddle and Turner, 1913.)
100 gms. $CHCl_3$ dissolve 11.56 gms. of the salt at 25°. (Peddle and Turner, 1913.)

**TETRA METHYL AMMONIUM PHOSPHOR HEXA FLUORIDE** $(CH_3)_4N.PF_6$.

One liter of saturated solution in water contains 1.68 gm. $(CH_3)_4N.PF_6$ at 21°. (Lange and Mueller, 1930.)

**FURFURAL** $C_4H_3O.CHO$.

RECIPROCAL SOLUBILITY OF FURFURAL AND WATER.
(Mains, 1922; Evans and Aylesworth, 1926.)

The determinations of Mains were made by shaking together furfural and water at nearly constant temperature for 100 times. After separation, the two layers were analyzed by measurement of their densities and comparing with a concentration-density chart. The determinations of Evans and Aylesworth were made by the sealed tube synthetic method and precautions were taken to secure the highest accuracy.

Results of Mains.

| t°. | Gms. $C_4H_3O.CHO$ per 100 gms. Water rich layer. | Furfural rich layer. |
|---|---|---|
| 10..... | 7.9 | 96.1 |
| 20..... | 8.3 | 95.2 |
| 30..... | 8.8 | 94.2 |
| 40..... | 9.5 | 93.3 |
| 50..... | 10.4 | 92.4 |
| 60..... | 11.7 | 91.4 |
| 70..... | 13.2 | 90.3 |
| 80..... | 14.8 | 88.7 |
| 90..... | 16.6 | 86.7 |
| 97.9 (b. t.). | 18.4 | 84.1 |

Results of Evans and Aylesworth.

| t°. | Gms. $C_4H_3O.CHO$ per 100 gms. Water rich layer. | Furfural rich layer. |
|---|---|---|
| 50..... | 9.2 | 92.2 |
| 60..... | 10.5 | 90.9 |
| 70..... | 12.2 | 89.1 |
| 80..... | 14.1 | 87.2 |
| 90..... | 16.5 | 84.9 |
| 100..... | 19.6 | 81.8 |
| 110..... | 25.0 | 76.5 |
| 120..... | 40.5 | 61.0 |
| 120.9 (crit. t.).. | | 50.7 |

SOLUBILITY OF FURFURAL IN WATER.
(Rothmund, 1898.)

The determinations were made by synthetic method, see Note, page 292

| t°. | Gms. $C_4H_3OCHO$ per 100 Gms. Aq. Layer. | Furfurol Layer. |
|---|---|---|
| 40 | 8.2 | 93.7 |
| 50 | 8.6 | 93 |
| 60 | 9.2 | 92 |
| 70 | 10.8 | 90.7 |
| 80 | 13 | 89 |
| 90 | 15.5 | 86.6 |

| t°. | Gms. $C_4H_3OCHO$ per 100 Gms. Aq. Layer. | Furfurol Layer. |
|---|---|---|
| 100 | 18.9 | 83.5 |
| 110 | 24 | 78.5 |
| 115 | 28 | 74.6 |
| 120 | 34.4 | 68.1 |
| 122.7 (crit. t.) | 51 | |

100 gms. Aq. 0.4 n sodium oleate solution (= 10.8 gm. Na oleate per 100 gms. solution) dissolve 14.75 gms. $C_4H_3OCHO$ at 20°. (Smith, 1932.)

## Equilibrium in the System Furfural, Iso Amyl Acetate and Water at 25°.

(Lloyd, Thompson and Ferguson, 1937.)

The determinations of the binodal curve were made by the titration method. To mixtures of weighed amounts of two of the components the third was added from a weight buret equipped with a long fine delivery tip. Tie lines were obtained from weights of the two phases separating from a mixtures of known composition or from these weights and the furfural content of the furfural rich phase.

| Gms. per 100 gms. homogeneous mixture | | | Gms. per 100 gms. homogeneous mixture | | |
|---|---|---|---|---|---|
| $C_4H_3OCHO$ | 1 $CH_3COOC_5H_{11}$ | $H_2O$ | $C_4H_3OCHO$ | 1 $CH_3COOC_5H_{11}$ | $H_2O$ |
| 0.9 | 0.2 | 98.8 | 58.4 | 39.0 | 2.6 |
| 1.8 | 0.5 | 97.7 | 53.5 | 43.6 | 2.9 |
| 3.8 | 0.4 | 95.8 | 48.2 | 49.4 | 2.4 |
| 5.8 | 1.2 | 93.0 | 43.2 | 54.6 | 2.2 |
| 7.3 | 1.9 | 90.8 | 39.9 | 58.0 | 2.1 |
| 7.7 | 0.0 | 92.3 | 29.5 | 68.7 | 1.8 |
| 94.7 | 0.0 | 5.3 | 19.7 | 38.7 | 1.6 |
| 88.8 | 0.0 | 4.6 | 9.7 | 89.2 | 1.1 |
| 78.4 | | 3.6 | 0.0 | 98.8 | 1.2 |

The percentage of furfural in adjoining layers fixing tie lines were:

| | | |
|---|---|---|
| Layer I | 2.0 | 16.0 |
| Layer II | 4.2 | 36.0 |

Similar results for systems containing furfural will be found under Acetone and Ethyl Acetate.

**URIC ACID** $C_5H_4N_4O_3$.

### Solubility in Water.

(Blarez and Deniges, 1887; at 15° Magnier, 1875.)

| t° | Gms. $C_5H_4N_4O_3$ per 100 Gms. $H_2O$. | t°. | Gms. $C_5H_4N_4O_3$ per 100 Gms. $H_2O$. | t°. | Gms. $C_5H_4N_4O_3$ per 100 Gms. $H_2O$. |
|---|---|---|---|---|---|
| 0 | 0.002 | 30 | 0.0088 | 70 | 0.0305 |
| 10 | 0.0037 | 40 | 0.0122 | 80 | 0.0390 |
| 15 | 0.0053 | 50 | 0.0170 | 90 | 0.0498 |
| 20 | 0.006 | 60 | 0.0230 | 100 | 0.0625 |

One liter of very carefully purified $CO_2$ free water dissolves 0.0253 gm. uric acid at 18°. Constant agitation and temperature were employed. With finely divided uric acid, saturation was reached after one hour. The amount dissolved was determined by the difference in weight between the amount of sample taken and that remaining undissolved. (His, Jr. and Paul, 1900.)

One liter of pure $CO_2$ free water dissolves 0.0649 gm. uric acid at 37°. The amount dissolved was determined by difference and only 20–25 minutes agitation allowed for saturation. It is stated that on long contact with water, the uric acid breaks down and the solubility and conductivity increase directly with time. (Gudzeit, 1909.)

One liter of water dissolves 0.0645 gm. uric acid at 37°. (Bechhold and Ziegler, 1910.)

One liter of serum dissolves 0.9 gm. uric acid at 37°. "

100 cc sat. solution of Uric Acid in Water contain 0.005 gm. $C_5H_4N_4O_3$ at 22°. (Yabana, 1929.) This author also gives results showing that the solubility of uric acid in water is increased by the presence of protein acids.

## Solubility of Uric Acid in Aqueous Solutions of Acid at 18°.

(His, Jr. and Paul, 1900.)

| Acid. | Concentration of Aq. Acid. Normality. | Per cent. | Gms. Uric Acid per 1000 cc. Sat Sol. |
|---|---|---|---|
| Hydrochloric | 1 | 3.65 | 0.0236 |
| " | 3.75 | 13.69 | 0.0263 |
| " | 6.24 | 22.77 | 0.0375 |
| Sulfuric | 1 | 4.9 | 0.0227 |
| | 3.2 | 15.67 | 0.0205 |
| | 6.4 | 31.34 | 0.0183 |

Additional data for the solubility of uric acid in aqueous sulfuric acid are given by Tafel (1901). A saturated solution of crystallized uric acid in 80 wt. per cent aqueous $H_2SO_4$ was prepared by warming to about 120° and allowing to stand. Portions of the clear solution were diluted with increasing amounts of water and the mixtures allowed to stand many days in closed flasks which were frequently shaken. The precipitated uric acid was then filtered off and weighed and the amount remaining in solution calculated by difference. The following results were obtained.

| | | | | | | |
|---|---|---|---|---|---|---|
| Wt. % of aq. $H_2SO_4$ | 72.5 | 70.5 | 68 | 66.5 | 62.5 | 59.5 |
| Gms. uric acid per 100 gms. aq. $H_2SO_4$ | 6.45 | 3.85 | 1.60 | 0.64 | 0.35 | 0.312 |

## Influence of Hydrogen Ion Concentration Upon the Solubility of Uric Acid.

(Jung, 1922, 1923.)

An excess of uric acid was shaken for two hours with buffer mixtures of determined $p_H$ values and the solution either filtered immediately or after 1 or 2 days. The dissolved uric acid was usually determined with Folin's uric acid reagent (phosphotungstic acid) and the standard solution of Benedict. The following results were obtained at the temperatures shown in parentheses with uric acid as the starting material and the indicated buffer mixtures. The calculated results were obtained with the aid of the Michaelis formula derived on the basis of the mass action law.

| $p_H$ of solvent. | Gms. Uric Acid dissolved per liter in Buffer mixtures A (22°). | KNa (22°). | B (22°). | A (15°-18°). | Na (15°-18°). | K (15°-18°). | Calculated gms. Uric Acid per liter. |
|---|---|---|---|---|---|---|---|
| 3.24 | 0.0271 | – | – | | – | – | 0.0236 |
| 5.0 | 0.0333 | – | – | – | – | – | 0.0271 |
| 5.4 | 0.0450 | – | – | – | – | – | 0.0324 |
| 5.6 | 0.0455 | – | – | 0.046 | 0.035 | 0.032 | 0.0376 |
| 5.8 | 0.063 | 0.110 | – | 0.064 | 0.042 | – | 0.0465 |
| 6.0 | 0.142 | 0.062 | | 0.130 | 0.058 | 0.056 | 0.0589 |
| 6.2 | 0.217 | 0.097 | – | 0.290 | 0.080 | 0.080 | 0.0795 |
| 6.4 | – | 0.166 | | – | 0.120 | 0.112 | 0.1123 |
| 6.6 | – | 0.217 | | – | 0.170 | 0.180 | 0.1640 |
| 6.8 | | 0.357 | 0.370 | – | 0.270 | 0.220 | 0.2465 |
| 7.0 | – | 0.500 | – | | 0.430 | 0.357 | 0.360 |
| 7.2 | | 0.816 | – | | 0.54 | 0.600 | 0.583 |
| 7.4 | – | 1.10 | – | – | 0.97 | 0.877 | 0.911 |
| 7.6 | – | 1.48 | 1.54 | – | 1.20 | (1.00) | 1.43 |
| 7.8 | | (1.74) | 2.08 | – | (1.33) | (1.19) | 2.25 |
| 8.0 | | (2.22) | 3.44 | | (1.39) | (1.19) | 3.56 |
| 8.2 | – | (2.50) | (3.77) | – | – | – | 5.62 |
| 8.7 | – | – | (5.26) | | – | – | – |

Buffer Mixture A = 0.1 $n$ $CH_3COONa$ + 0.1 $n$ $CH_3COOH$ ($p_H$ = 3.24 — 6.20).
" " KNa = 0.067 mol. $KH_2PO_4$ + 0.067 mol. $Na_2HPO_4$.
" " B = 0.1 mol. Borax + 0.2 mol. Boric Acid ($p_H$ = 6.77 — 9.24).
" " Na = 0.067 mol. $NaH_2PO_4$ + 0.067 mol. $Na_2HPO_4$ ($p_H$ = 5.6 — 8.2).
" " K = 0.067 mol. $KH_2PO_4$ + 0.067 mol. $K_2HPO_4$.

Results are also given for determinations made at 37° and with sodium urate as the starting material. The influence of the anion present and of the time of shaking and of standing was also studied. Similar curves were obtained in all cases and they show that the greatest effect upon the solubility of uric acid, resulting from a change of $p_H$, occurs in the vicinity of the neutral point, which is the reaction of the blood.

## The Solubility of Uric Acid in Buffer Solutions at 37°.

(Harpuder and Erbsen, 1924.)

Buffer mixtures were prepared with primary and secondary sodium phosphate, sodium acetate and acetic acid, and sodium lactate and lactic acid. Each was diluted to 100 cc. with distilled or conductivity water. An excess of a weighed amount of the purest uric acid was added to each solution and the mixture shaken in a thermostat one-fourth of an hour, and then allowed to stand one hour. The undissolved uric acid was filtered out and weighed, and that dissolved calculated by difference. A direct determination of the uric acid in the saturated solution was also made by titration with sulfuric acid and potassium permanganate. The average of the two determinations was taken as the solubility in each buffer mixture. A determination of the $p_H$ of each saturated solution was made with the gas chain.

| Per 100 cc. Buffer mixture. | | | Gms. Uric Acid | Per 100 cc. Buffer mixture. | | | Gms. Uric Acid |
|---|---|---|---|---|---|---|---|
| Cc. 0.1 *n* $CH_3COONa$. | Cc. 0.1 *n* $CH_3COOH$. | $p_H$ of sat. sol | per liter sat. sol. | Cc. 0.1 *n* $CH_3COONa$. | Cc. 0.1 *n* $CH_3COOH$. | $p_H$ of sat. sol. | per liter sat. sol. |
| 10 | 0.0 | 6.16 | 0.260 | 10 | 9.6 | 4.78 | 0.122 |
| 10 | 0.3 | 6.00 | 0.213 | 10 | 19.2 | 4.45 | 0.110 |
| 10 | 0.6 | 5.62 | 0.198 | 10 | 38.4 | 4.14 | 0.093 |
| 10 | 1.2 | 5.42 | 0.175 | 0 | 40.0 | 3.26 | 0.068 |
| 10 | 2.4 | 5.23 | 0.137 | 100 cc. 1.0 *n* $CH_3COOH$ | | 0.1 | 0.086 |
| 10 | 4.8 | 5.06 | 0.129 | | | | |

| Per 100 cc. Buffer mixture. | | | Gms. Uric Acid | Per 100 cc. Buffer mixture. | | | Gms. Uric Acid |
|---|---|---|---|---|---|---|---|
| Cc. 0.33 mol. $Na_2HPO_4$. | Cc. 0.33 mol. $Na_2HPO_4$. | $p_H$ of sat. sol. | per liter sat. sol. | Cc. 0.1 *n* Na lactate. | Cc. 0.1 *n* Lactic acid. | $p_H$ of sat. sol. | per liter sat. sol. |
| 1.8 | 3.6 | 6.78 | 1.171 | 10 | 0 | 5.25 | 0.155 |
| 3.0 | 3.0 | 6.61 | 0.780 | 10 | 0.3 | 4.99 | 0.144 |
| 4.5 | 2.25 | 6.47 | 0.510 | 10 | 0.6 | 4.84 | 0.135 |
| 6.0 | 1.5 | 6.21 | 0.361 | 10 | 2.4 | 4.53 | 0.107 |
| 7.2 | 0.9 | 5.97 | 0.249 | 10 | 4.8 | 4.15 | 0.098 |
| 7.99 | 0.5 | 5.71 | 0.184 | 0 | 40.0 | 2.78 | 0.098 |
| 8.47 | 0.26 | 5.52 | 0.153 | 100 cc. 0.001 *n* HCl | | 3.29 | 0.054 |
| 9.00 | 0.0 | 4.61 | 0.097 | 100 cc. 0.001 *n* $H_2SO_4$ | | 3.29 | 0.054 |

The curves obtained by plotting the above results show that the solubility of uric acid in acetate and lactate buffer mixtures differs from that in phosphate buffers. Additional evidence on this point, and on the marked tendency of uric acid to form supersaturated solutions, was desired. Further determinations were therefore, made by Harpuder, 1924, using a method designed to show more clearly the effect of the anion (at higher concentrations) upon the solubility of uric acid.

An amount of dried uric acid, which was chosen to yield an equal excess in all cases, was dissolved by warming, in a portion of the alkaline part of the buffer mixture. The remaining portions were then added in amounts such that the concentration of $Na^+$ remained constant, and the mixture was diluted to 40 cc. The amount of added uric acid was controlled by a colorimetric determination made with phosphotungstic acid and sodium cyanide. The mixture was shaken one-fourth of an hour at 37° and then allowed to stand at this temperature for 36 hours. It was then filtered and the uric acid again determined colorimetrically in one portion of the filtrate and the $p_H$ measured in another by means of the gas chain.

The $p_H$ corresponding to the beginning of precipitation of uric acid or urate was considered to be a more satisfactory indication of the solubility influence than the amount of uric acid dissolved. The results of such measurements, made under conditions so chosen that all factors remained constant except the concentration of the anion, showed that the precipitation of uric acid from :

Phosphate buffer mixture begins at $p_H$ = about 6.8
Acetate » » » » » = » 4.9
Lactate » » » » » = » 4.2

On the basis of many experiments and calculations it was concluded that the failure of the excess of mono urate to precipitate from its supersaturated solution depends upon the simultaneous presence of undissociated uric acid and *diurate*, and accordingly is possible first at a definite $p_H$ upwards of $> 6.7$ to 6.8. The failure of uric acid complexes to precipitate from acetic acid and lactic acid mixtures is caused by supersaturation of undissociated uric acid due to the buffer acid. Non electrolytes and colloids may favorably influence the holding of uric acid complexes in solution.

By constant agitation at 14°. 0 ± 0°. 5 for more than 24 hours Biltz and Herrmann, 1923, found that 1000 cc. water dissolve 0.0223 gm. uric acid when equilibrium was approached from below, and 0.0295 gm. when equilibrium was approached from above.

SOLUBILITY OF URIC ACID AT ABOUT 18° IN AQUEOUS SOLUTIONS OF:
(Lang and Lang. 1927.)

| Sodium Bicarbonate | | | | Sodium Carbonate | | | |
|---|---|---|---|---|---|---|---|
| Normality of aq. $NaHCO_3$ | Gms. $C_5H_4O_3N_4$ per 100 cc sat. sol. | Normality of aq. $NaHCO_3$ | Gms. $C_5H_4O_3N_4$ per 100 cc sat. sol. | Normality of aq. $Na_2CO_3$ | Gms. $C_5H_4O_3N_4$ per 100 cc sat. sol. | Normality of aq. $Na_2CO_3$ | Gms. $C_5H_4O_3N_4$ per 100 cc sat. sol. |
| 0.0074 | 0.013 | 0.0066 | 0.058 | 0.00074 | 0.014 | 0.0066 | 0.077 |
| 0.0011 | 0.017 | 0.010 | 0.078 | 0.00123 | 0.021 | 0.01 | 0.107 |
| 0.00185 | 0.025 | 0.011 | 0.080 | 0.00185 | 0.029 | 0.0111 | 0.122 |
| 0.0022 | 0.028 | 0.0125 | 0.082 | 0.0022 | 0.031 | 0.0125 | 0.133 |
| 0.0025 | 0.033 | 0.0166 | 0.103 | 0.0025 | 0.036 | 0.0166 | 0.169 |
| 0.0033 | 0.038 | 0.02 | 0.114 | 0.0037 | 0.051 | 0.020 | 0.198 |
| 0.0037 | 0.040 | 0.025 | 0.124 | 0.005 | 0.062 | 0.025 | 0.235 |
| 0.005 | 0.044 | 0.033 | 0.150 | 0.0055 | 0.070 | 0.033 | 0.306 |
| 0.00555 | 0.052 | 0.05 | 0.193 | 0.00625 | 0.077 | 0.05 | 0.420 |
| 0.00625 | 0.056 | 0.10 | 0.284 | | | | |

Sodium Carbonate + Carbon Dioxide

| Normality of aq. $NaHCO_3$ | Gms. dissolved $CO_2$ | Gms. Total $CO_2$ | Gms. $C_5H_4O_3N_4$ per 100 cc sat. sol. |
|---|---|---|---|
| 0.0025 | 0.00275 | 0.0085 | 0.022 |
| 0.005 | 0.0055 | 0.0136 | 0.031 |
| 0.010 | 0.011 | 0.0224 | 0.0437 |
| 0.020 | 0.022 | 0.0362 | 0.0541 |
| 0.0025 | 0.019 | 0.0228 | 0.0140 |
| 0.005 | 0.038 | 0.0423 | 0.0159 |
| 0.010 | 0.072 | 0.0816 | 0.0176 |
| 0.020 | 0.154 | 0.1593 | 0.0202 |

The solubility increases and becomes twice as great when the equilibrium is established by stirring with a sufficient quantity of air (900cc per 100cc of solution.)

100 gms. Abs. Alcohol dissolve 0.68 gm uric acid at 20–25°. (Pucher and Dehn, 1921.)
» Quinoline » 1.13 » » » » » » »
» equi mol. mixture of alcohol and quinoline dissolve 0.61 gm. uric acid at 20-25°.

An approximate determination of the solubility of uric acid in alcohol by extraction in a Soxhlet apparatus, gave 0.00008 gms. per 100 cc. A similar determination with ether as solvent, gave negative results. (Gortner, 1914.)
100 gms. 95% formic acid dissolve 0.04 gm. uric acid at 20°. (Aschan, 1913.)
" pyridine dissolve 0.21 gm. uric acid at 20–25°. (Dehn, 1917.)
" aq. 50% pyridine dissolve 0.75 gms. uric acid at 20–25°. "

## Methyl **URIC ACIDS**.

### Solubility of Ordinary Uric Acid and of Several Methyl Uric Acids in Water at the Boiling Point.

(Biltz and Heyn, 1917.)

About 400 cc. of water containing several grams of the given uric acid were boiled under a reflux condenser for 2 hours. The saturated solution was analyzed by evaporating a weighed sample in a platinum dish and weighing the residue after drying one-fourth of an hour at 110°.

| Compound. | Gms. compound per 1000 cc. $H_2O$. | Compound. | Gms. compound per 1000 cc. $H_2O$. |
|---|---|---|---|
| Uric acid..... | 0.800 | α Methyl Uric acid | 5.002 |
| 9-Methyl Uric acid... | 0.546 | 3.7 Di methyl Uric acid | 3.448 |
| δ » » » ... | 1.588 | 90 % δ + 10 % 9-Methyl Uric acid | 2.777 |
| ζ » » » ... | 2.105 | 70 % δ + 30 % 9- » » » | 3.703 |

## **THIOPHENE** Mono**CARBONIC ACIDS** α, β and *a* $C_4H_3SCOOH$.

The solubility of the three isomers is given by Voerman (1907) as 0.57 gm. of the α acid per 100 cc. sat. solution at 21°; 0.445 gm. of the β acid at 18°, and 0.75 gm. of the *a* acid at 17°. The solvent is not stated. Data for the solidification points of mixtures of the α and β acid are also given.

## **PYRIDINE** $CH < (CH.CH)_2 > N$.

### Solubility in Water, Determined by the Freezing-point Method.

(Average curve from results of Pickering (1893) and Baud (1909.)

| t°. of Solidification. | Gms. $C_5H_5N$ per 100 Gms. Mixture. | Solid Phase. | t° of Solidification. | Gms. $C_5H_5N$ per 100 Gms. Mixture. | Solid Phase. | t° of Solidification. | Gms. $C_5H_5N$ per 100 Gms. Mixture. | Solid Phase. |
|---|---|---|---|---|---|---|---|---|
| 0 | 0 | Ice | −10 | 58.5 | Ice | −60 | 84 | Ice |
| −1 | 7.5 | " | −12.5 | 62 | " | −65 Eutec. | 85 | " + $C_5H_5N$ |
| −2 | 17 | " | −15 | 64.5 | " | −60 | 87 | $C_5H_5N$ |
| −3 | 28 | " | −20 | 68 | " | −55 | 89 | " |
| −4 | 37.5 | " | −25 | 71 | " | −50 | 92 | " |
| −5 | 43.5 | " | −30 | 73.5 | " | −45 | 95 | " |
| −6 | 48 | " | −40 | 78 | " | −40 | 97 | " |
| −8 | 54 | " | −50 | 81.5 | " | −38 m. pt. | 100 | " |

Timmermans (1912) is reported to have made determinations on the above systems but the original paper could not be located.
Baud also gives data for the densities of pyridine + water mixtures.

The following more recent determinations are by Ewert, 1937.

| t° | Mol. Percent $C_5H_5N$ in Mixture | t° | Mol. Percent $C_5H_5N$ in Mixture |
|---|---|---|---|
| - 2.9(- 4.0) | 10.0 | -69.2(-64.1) | 60.0 |
| - 9.0(- 8.0) | 20.0 | -61.9(-57.3) | 70.0 |
| -21.7(-17.4) | 30.0 | -76.0(-66.0)Eutec. | — |
| -36.4(-28.4)Eutec. | — | -54.7(-51.3) | 80.0 |
| -40.2(-32.2) | 40.0 | -47.9(-45.8) | 90.0 |
| -55.0(-47.5) | 50.0 | | |

The temperatures in parentheses are quoted by Ewert from the unpublished results of S. Frederic and R. Rayet.

## Equilibrium in the System Pyridine, Phenol and Water.

(Mertzline, 1936.)

The temperature of homogeneity and composition of mixtures containing:

| 5 Wt. % $C_5H_5N$ | | | 10 Wt. % $C_5H_5N$ | | | 20 Wt. % $C_5H_5N$ | | |
|---|---|---|---|---|---|---|---|---|
| t° | Wt. % $H_2O$ | Wt. % $C_6H_5OH$ | t° | Wt. % $H_2O$ | Wt. % $C_6H_5OH$ | t° | Wt. % $H_2O$ | Wt. % $C_6H_5OH$ |
| 80.5 | 93.0 | 2.0 | 52.2 | 89.0 | 1.0 | 80.5 | 77.5 | 2.5 |
| 94.3 | 92.2 | 3.0 | 87.0 | 88.0 | 2.0 | 109.4 | 75.0 | 5.0 |
| 112.6 | 90.0 | 5.0 | 108.4 | 86.5 | 3.5 | 131.2 | 69.9 | 10.1 |
| 128.4 | 85.0 | 10.0 | 123.2 | 84.0 | 6.0 | 142.4* | 60.0 | 20.0 |
| 130.1 | 75.0 | 20.0 | 140.6 | 75.0 | 15.0 | 143.0 | 48.6 | 31.4 |
| 122.6 | 65.6 | 29.4 | 133.5* | 57.6 | 32.4 | 138.4 | 40.1 | 39.9 |
| 113.6* | 56.4 | 38.6 | 119.3 | 40.0 | 50.0 | 125.5 | 28.5 | 51.6 |
| 103.0 | 44.9 | 50.1 | 103.6 | 30.7 | 59.3 | 97.2 | 18.0 | 62.0 |
| 85.2 | 33.7 | 61.3 | 69.5 | 20.1 | 69.9 | 73.6 | 13.3 | 66.7 |
| 59.8 | 25.0 | 70.0 | | | | | | |

| 30 Wt. % $C_5H_5N$ | | | 40 Wt. % $C_5H_5N$ | | | 50 Wt. % $C_5H_5N$ | | |
|---|---|---|---|---|---|---|---|---|
| t° | Wt. % $H_2O$ | Wt. % $C_6H_5OH$ | t° | Wt. % $H_2O$ | Wt. % $C_6H_5OH$ | t° | Wt. % $H_2O$ | Wt. % $C_6H_5OH$ |
| 75.6 | 65.0 | 5.0 | 51.0 | 53.0 | 7.0 | 69.7 | 36.0 | 14.0 |
| 117.1* | 59.6 | 10.4 | 89.3* | 49.7 | 10.2 | 92.1* | 30.0 | 30.0 |
| 135.5 | 50.2 | 19.8 | 105.5 | 47.0 | 13.0 | 90.2 | 20.0 | 30.0 |
| 140.0 | 40.1 | 29.9 | 123.7 | 40.0 | 20.0 | 71.8 | 15.0 | 35.0 |
| 136.5 | 31.8 | 38.2 | 127.0 | 30.1 | 29.9 | | | |
| 117.8 | 20.1 | 49.9 | 117.1 | 20.0 | 40.0 | | | |
| 89.4 | 13.0 | 57.0 | 96.8 | 15.0 | 45.0 | | | |
| | | | 65.7 | 10.2 | 49.8 | | | |

* Critical opalescence

Composition of the mixtures near the upper critical point.

| t° | Gms. per 100 gms. mixture | | |
|---|---|---|---|
| | $H_2O$ | $C_5H_5N$ | $C_6H_5OH$ |
| 143.5 | 63.4 | 15.8 | 20.8 |
| 143.5 | 58.4 | 18.3 | 23.3 |
| 143.8 | 56.5 | 18.5 | 25.0 |

## Equilibrium in the System Pyridine, Aniline and Water.

(Ousti-Katchkintzev and Mertzline. 1936.)

Results at 0°

| Gms. per 100 gms. homogeneous mixture | | |
|---|---|---|
| $H_2O$ | $C_5H_5N$ | $C_6H_5NH_2$ |
| — | — | — |
| 69.3 | 23.1 | 7.6 |
| 52.2 | 32.0 | 15.8 |
| 46.3 | 35.3 | 18.4 |
| 40.4 | 37.7 | 21.9 |
| 24.0 | 39.6 | 36.4 |
| 18.5 | 37.2 | 44.3 |
| 9.3 | 17.2 | 73.5 |

Results at 50°

| Gms. per 100 gms. homogeneous mixture | | |
|---|---|---|
| $H_2O$ | $C_5H_5N$ | $C_6H_5NH_2$ |
| 89.1 | 7.9 | 3.0 |
| — | — | — |
| 51.5 | 33.0 | 15.5 |
| — | — | — |
| 40.9 | 37.7 | 21.4 |
| — | — | — |
| 19.9 | 36.6 | 43.5 |

The authors also give results for the quaternary systems Pyridine, Pyperidine, Aniline and Water at 0°, 20°, and 50° and for Pyridine, Piperidine, Acetic Acid and Water at 0°.

## Distribution of Pyridine at 25° Between :

(Smith, 1921, 1922.)

Water and Chloroform.

| Millimols. $C_5H_5N$ per liter of | | $\frac{C_2}{C_1}$ |
|---|---|---|
| $H_2O$ layer ($C_1$). | $CHCl_3$ layer ($C_2$). | |
| 0.225 | 1.225 | 5.4 |
| 0.30 | 2.2 | 7.3 |
| 0.55 | 5.10 | 9.3 |
| 1.45 | 16.25 | 11.2 |

Water and Xylene.

| Millimols. $C_5H_5N$ per liter of | | $\frac{C_2}{C_1}$. |
|---|---|---|
| $H_2O$ layer ($C_1$). | Xylene layer ($C_2$). | |
| 1.00 | 1.90 | 1.90 |
| 2.05 | 3.80 | 1.85 |
| 4.80 | 9.50 | 1.98 |
| 9.75 | 19.00 | 1.95 |

## Distribution of Pyridine Between Water and Benzene at 25°.

(Woodman and Corbet, 1925.)

Measured volumes of benzene, water and pyridine were placed in stoppered graduated cylinders. The mixtures were maintained at 25° for 6 hours and vigorously shaken periodically. The volume of the two layers was noted and known volumes of each weighed and the pyridine in them determined by titration with normal acid, using methyl orange as indicator. The volume of benzene was measured.

Benzene layer.

| Density. | Wt. % Pyridine. | Wt. % $C_6H_6$. |
|---|---|---|
| 0.874 | 3.28 | 94.54 |
| 0.882 | 9.75 | 87.46 |
| 0.983 | 18.35 | 79.49 |
| 0.903 | 26.99 | 71.31 |
| 0.909 | 31.42 | 66.46 |
| 0.911 | 34.32 | 64.48 |
| 0.915 | 36.85 | 59.35 |
| 0.918 | 39.45 | 56.43 |
| 0.914 | 39.27 | 55.72 |

Water Layer.

| Density. | Wt. % Pyridine. | Wt. % $C_6H_6$. |
|---|---|---|
| 0.994 | 1.17 | 0.0 |
| 0.995 | 3.55 | 0.0 |
| 0.998 | 7.39 | trace |
| 0.997 | 13.46 | 0.15 |
| 0.997 | 22.78 | 0.25 |
| 0.996 | 32.15 | 0.44 |
| 0.997 | 42.47 | 2.38 |
| 0.990 | 48.87 | 3.99 |
| 0.991 | 49.82 | 4.28 |

## Distribution of Pyridine between Water and Benzene.

At Room Temperature.
(v. Georgievics, 1915.)

| Gms. $C_5H_5N$ per 25 cc. $H_2O$ Layer. | Gms. $C_5H_5N$ per 75 cc. $C_6H_6$ Layer. |
|---|---|
| 0.0617 | 0.4733 |
| 0.0958 | 0.7631 |
| 0.1549 | 1.2249 |
| 0.2432 | 2.0096 |
| 0.3297 | 2.6553 |
| 0.723 | 5.4159 |
| 1.147 | 9.878 |

At 25°.
(Hantzsch and Sebaldt, 1899.)

| | Mols. $C_5H_5N$ per Liter. Aq. Layer. | $C_6H_6$ Layer. | Ratio. |
|---|---|---|---|
| | 0.00148 | 0.00436 | 0.339 |
| | 0.00076 | 0.00226 | 0.339 |
| | 0.00038 | 0.00110 | 0.345 |
| | 0.000208 | 0.000546 | 0.381 |
| | 0.000112 | 0.000274 | 0.413 |
| (at 5.5°) | 0.000456 | 0.000928 | 0.491 |
| (at 50°) | 0.000314 | 0.001088 | 0.289 |

## Distribution of Pyridine between Water and Toluene.
(Hantzsch and Vagt, 1901.)

At 25°.

| Mols. $C_5H_5N$ per Liter. Aq. Layer. | $C_6H_5CH_3$ Layer. | Ratio. |
|---|---|---|
| 0.0517 | 0.1129 | 0.458 |
| 0.0261 | 0.0559 | 0.466 |
| 0.0132 | 0.0275 | 0.481 |
| 0.0067 | 0.0137 | 0.496 |
| 0.0033 | 0.0066 | 0.551 |
| 0.0019 | 0.0034 | 0.629 |
| 0.0011 | 0.0017 | 0.647 |
| 0.0007 | 0.0010 | 0.696 |

At Various Temperatures.

| t°. | Mols. $C_5H_5N$ per Liter. Aq. Layer. | $C_5H_5CH_3$ Layer. | Ratio. |
|---|---|---|---|
| 0 | 0.0168 | 0.0201 | 0.840 |
| 10 | 0.0135 | 0.0215 | 0.627 |
| 20 | 0.0111 | 0.0228 | 0.529 |
| 30 | 0.0108 | 0.0234 | 0.461 |
| 40 | 0.0101 | 0.0245 | 0.411 |
| 50 | 0.0096 | 0.0252 | 0.380 |
| 70 | 0.0085 | 0.0263 | 0.324 |
| 90 | 0.0082 | 0.0266 | 0.307 |

Data for systems composed of pyridine, water and various inorganic salts are given by Timmermans, 1907.

## Reciprocal Solubility, Determined by Freezing-point Method, of Mixtures of

Benzene and Phenol.
(Hatcher and Skirrow, 1917.)

| t° of Melting. | Gms. $C_6H_6$ per 100 Gms. Mixture. | Solid Phase. |
|---|---|---|
| 39.4 | 0 | $C_6H_5OH$ |
| 30 | 11.8 | " |
| 20 | 25 | " |
| 10 | 38.2 | " |
| 0 | 51.5 | " |
| − 5.4 Eutec. | 58.4 | " $+C_6H_6$ |
| − 2.5 | 67.5 | $C_6H_6$ |
| 0 | 78.3 | " |
| + 2.5 | 89 | " |
| 5.1 | 100 | " |

Benzene and Pyridine.
(Hatcher and Skirrow, 1917.)

| t° of Melting. | Gms. $C_5H_5$ per 100 Gms. Mixture. | Solid Phase. |
|---|---|---|
| −39.4 | 0 | $C_5H_5N$ |
| −45 | 10 | " |
| −50 | 17 | " |
| −55 | 23.3 | " |
| −58 Eutec. | 26 | " $+C_6H_6$ |
| −50 | 31 | $C_6H_6$ |
| −40 | 37.7 | " |
| −30 | 46 | " |
| −20 | 57 | " |
| −10 | 71.5 | " |
| 0 | 90.5 | " |

Additional data on the system Benzene + Phenol are given by Dahms, 1895; Paterno and Ampola, 1897; Tsakalotos and Guye, 1910, and Rozsa, 1911. Additional data on the system Benzene + Pyridine are given by Pickering, 1893.

The critical solution temperature of mixtures of Pyridine and n Heptane is -22.8°.

The critical solution temperature of mixtures of Pyridine and i Octane (2.2.4-Tri methyl pentane) is -15.0°. (Cornish, Archibald, Murphy and Evans, 1934.)

The critical solution temperature of mixtures of pyridine and sulfur is at 161° and the mixture contains 30 percent $C_5H_5N$. (Hammick and Holt, 1926, 1927.)

Freezing-point data are given for mixtures of:

| | | |
|---|---|---|
| Pyridine | + Acetic Acid | (Puschin and Rikovsky, 1932a.) |
| " | + Chloro Benzene | (Burnham and Madgin, 1936.) |
| " | + p Chloro Phenol | " " " |
| " | + Guaicol | (Puschin and Vaic, 1926.) |
| " | + Methyl Iodide | (Wroczinski and Guye, 1910.) |
| " | + Naphthalene | (Hatcher and Skirrow, 1917.) |

Results for mixtures of Pyridine and Benzoic acid are given by Baskov, 1914.

Results for mixtures of pyridine and each of the following compounds: phenol, chloro phenol, o, m and p cresol and naphthalene are given by Bramley, 1916 and Hatcher and Skirrow, 1917.

## PYRIDINAMINO SUCCINIC ACIDS.

100 gms. $H_2O$ dissolve 1.67 gms. of the *d* compound, 1.64 gms of the *l* compound and 1.68 gms. of the *dl* compound at 18°. (Lutz, 1910.)

## PYRIDINE Phosphor Hexa Fluoride $C_5H_5N.HPF_6$.

One liter sat. solution of Pyridine Phosphor Hexa fluoride in Water contain 0.18 gm. $C_5H_5N.HPF_6$ at 19°. (Lange and Müller, 1930.)

## TRI METHYLENE CYANIDE (Glutaronitrile) $CN.CH_2.CH_2.CH_2CN$.

RECIPROCAL SOLUBILITY OF TRIMETHYLENE CYANIDE AND WATER.
(Serwy, 1933.)

| t° | Gms. $H_2O$ per 100 gms. Mixture | t° | Gms. $H_2O$ per 100 gms. Mixture | t° | Gms. $H_2O$ per 100 gms. Mixture |
|---|---|---|---|---|---|
| -1.2tr.pt. | — | 68.1 | 41.99 | 68.1 | 58.05 |
| +5.6 | 6.0 | 68.2 | 44.96 | 66.7 | 64.92 |
| 34.85 | 11.6 | 68.25 | 49.26 | 65.5 | 67.92 |
| 55.3 | 20.7 | 68.3* | 51.17 | 63.6 | 71.17 |
| 64.3 | 30.0 | 68.3 | 53.25 | 56.0 | 78.29 |
| 67.5 | 38.12 | 68.2 | 55.21 | 21.7 | 89.5 |

* Critical opalescence.

## GALLIC ALDEHYDE 3.4.5.$(OH)_3C_6H_2CHO.H_2O$.

100 gms. $H_2O$ dissolve 0.1 gm. aldehyde at 0° and 5.8 gms. at 50°. (Rosenmund and Zetzsche, 1918.)

**METHYL BARBITURIC ACID** $NHCONHCOCH(CH_3)CO$

Freezing-point data for mixtures of n Methyl barbfturic acid with Antipyrine and with Pyramidon are given by Hammick and Hanson, 1933.

**MESACONIC ACID** (Methyl fumaric acid) $C_3H_3(COOH)_2$.

SOLUBILITY OF MESACONIC ACID IN SEVERAL SOLVENTS. (Lebrun, 1925.)

| Solvent. | t°. | Gms. $C_3H_3(COOH)_2$ per 100 gms. solvent. |
|---|---|---|
| Acetylene dichloride, cis. b. pt. 60°.2..... | 40 | 0.006 |
| » » trans. b. pt. 48°.3.. | 40 | 0.046 |
| Crotonic nitrile, b. pt. 107.7-108.2..... | 30 | 1.049 |
| » » » 121.8-122.2..... | 30 | 0.72 |

**CITRACONIC ACID** (Methyl Maleic Acid) $CH_3C.(COOH) : HC.COOH$.

SOLUBILITY OF CITRACONIC ACID IN SEVERAL SOLVENTS. (Lebrun, 1925.)

| Solvent. | t° | Gms. $C_5H_6O_4$ per 100 gms. solvent. |
|---|---|---|
| Crotonic nitrile (b pt. 107°.7-108°.2)..... | 30 | 30.52 |
| » (b. pt. 121°.8-122°.2)..... | 30 | 25.93 |
| Dichlor acetylene (cis) (b. pt. 60°.2)..... | 40 | 0.69 |
| » (trans) (b. pt. 48°.3)..... | 40 | 0.047 |

**ITACONIC ACID** $CH_2:C(COOH)CH_2COOH$.

Data for the distribution of itaconic acid between water and ether at 25° are given by Chandler, 1908.

**ASPARTIC ACID HYDANTOIN** $C_5H_6O_4N$.

SOLUBILITY IN WATER AND IN ETHYL ALCOHOL AT 25°.
(McMeekin, Cohn and Weare, 1935.)

| Solvent | d. of sat. sol. | Gm. Mol. $C_5H_6O_4N$ per liter |
|---|---|---|
| $H_2O$ | 1.0016 | 0.0705 |
| $C_2H_5OH$ | 0.7878 | 0.0141 |

**METHYL TRICHLORO β HYDROXY BUTYRATE** $CCl_3CHOHCH_2COOCH_3$.

Freezing-point data for mixtures of the isomerides of methyl tri chloro β Hydroxy Butyrate are given by Ross, 1936.

**DI ACETYL METHYL d TARTRATE** $(CHOCOCH_3CO_2CH_3)_2$.

Freezing-point data for mixtures of the d and l compound are given by Findlay and Campbell, 1928.

## ACETYLACETONE $CH_3COCH_2COCH_3$.

### Solubility in Water.

(Rothmund — Z. phys. Ch. 26, 475, '98.)

| t°. | Gms. $CH_3COCH_2COCH_3$ per 100 Gms. $H_2O$ Layer. | Acetyl Acetone Layer. |
|---|---|---|
| 30 | 15.46 | 95.02 |
| 40 | 17.58 | 93.68 |
| 50 | 20.22 | 91.90 |
| 60 | 23.23 | 89.41 |
| 70 | 27.10 | 85.77 |
| 80 | 33.92 | 78.82 |
| 87.7 (crit. temp.) | 56.8 | |

Note. — Weighed amounts of water and acetyl acetone were placed in small glass tubes, which were then sealed and slowly heated until the contained mixtures became homogeneous. The temperature was then allowed to fall very gradually and the point noted at which cloudiness appeared. This point was accurately established for each tube by repeated trials. The curve plotted from these determinations shows two percentage amounts of acetyl acetone which cause cloudiness at each temperature below the critical point. Of these two points, for each temperature, one represents the aqueous layer, *i.e.*, the solubility of acetyl acetone in water; and the other represents the acetyl acetone layer, *i.e.*, the solubility of water in acetyl acetone. This method is known as the 'Synthetic Method," and yields results in harmony with those obtained by the analytical method, *i.e.*, by analyzing each layer after complete separation occurs.

100 gms. sat. sol. of Acetyl acetone in ordinary water ($H_2O$) contain 17.05 gms. $C_5H_8O_2$ at 19.5°.

100 gms. sat. sol. of Acetyl acetone in heavy water ($D_2O$) contain 10.6 gms. $C_5H_8O_2$ at 19.5°. (Nachod, 1938.)

## α AMINO n BUTYRIC HYDANTOIN $C_5H_8O_2N_2$.

### Solubility in Aqueous Solutions of Ethyl Alcohol at 25°.

(McMeekin, Cohn and Weare, 1935.)

| Vol. % $C_2H_5OH$ in Aq. Solvent | d. of sat. sol. | Gm. Mols. $C_5H_8O_2N$ per liter sat. sol. | Vol. % $C_2H_5OH$ in Aq. Solvent | d. of sat. sol. | Gm. Mols. $C_5H_8O_2N$ per liter sat. sol. |
|---|---|---|---|---|---|
| 0.0 (= $H_2O$) | 1.0223 | 0.863 | 80 | 0.9713 | 2.408 |
| 20 | 1.0118 | 1.233 | 90 | 0.9222 | 1.971 |
| 40 | 1.0092 | 2.053 | 100 | 0.8969 | 0.988 |
| 60 | 1.0008 | 2.725 | | | |

## LEVULINIC ACID (β acetyl propionic Acid.) $CH_3COCH_2CH_2COOH$.

### Distribution of Levulinic Acid Between Water and Ether at 25°.

(Smith, 1921, 1922.)

| Millimols per liter. Aq. layer ($C_1$). | Millimols per liter. $(C_2H_5)_2O$ layer $C_2$. | $\frac{C_2}{C_1}$. | M Illufols per liter. Aq. layer ($C_1$). | M Illufols per liter. $(C_2H_5)_2O$ layer $C_2$. | $\frac{C_2}{C_1}$. |
|---|---|---|---|---|---|
| 1.725 | 0.500 | 0.2900 | 10.10 | 2.65 | 0.2625 |
| 2.57 | 0.725 | 0.2820 | 14.65 | 3.75 | 0.2575 |
| 5.15 | 1.40 | 0.2725 | | | |

DISTRIBUTION OF LEVULINIC ACID AT 25° BETWEEN :
(Smith, 1921, 1922.)

Water and Chloroform.

| Millimols per liter. $H_2O$ layer ($C_1$). | $CHCl_3$ layer ($C_2$). | $\frac{C_2}{C_1}$. |
|---|---|---|
| 12.80 | 0.75 | 0.0586 |
| 18.55 | 1.35 | 0.0728 |
| 24.5 | 2.00 | 0.0817 |

Water and Xylene

| Millimols per liter. $H_2O$ layer ($C_1$). | $C_6H_4(CH_3)_2$ layer ($C_2$). | $\frac{C_2}{C_1}$. |
|---|---|---|
| 26.0 | 0.50 | 0.0192 |
| 35.0 | 0.80 | 0.0228 |
| 51.7 | 1.40 | 0.0271 |

**GLUTARIC ACID** (Pyrotartaric) $(CH_2)_3(COOH)_2$.

SOLUBILITY IN WATER. (Lamouroux, 1899)

| t°. | 0°. | 15°. | 20°. | 35°. | 50°. | 65°. |
|---|---|---|---|---|---|---|
| Gms. $(CH_2)_3(COOH)_2$ per 100 cc. solution | 42.9 | 58.7 | 63.9 | 79.7 | 95.7 | 111.8 |

100 gms. 95% formic acid dissolve 55.62 gms. glutaric acid at 18.6°. (Aschan, 1913.)
Data for the distribution of glutaric acid between water and ether at 25° are given by Chandler, 1908.
F. pt. data for glutaric acid + sulfuric acid. (Kendall and Carpenter, 1914.)

100 gms. benzene dissolve 0.0163 gm. $(CH_2)_3(COOH)_2$ at 25°. (Verkade and Coops, 1930.)

**GLUTARIC ACID** (Pyrotartaric Acid) $CH_2(CH_2COOH)_2$.

DISTRIBUTION OF GLUTARIC ACID AT 25° BETWEEN :
(Smith, 1921-1922.)

Water and Chloroform.

| Millimols. per liter. $H_2O$ layer ($C_1$). | $CHCl_3$ layer ($C_2$). | $\frac{C_2}{C_1}$. |
|---|---|---|
| 17.9 | 0.375 | 0.0210 |
| 24.7 | 0.570 | 0.0231 |
| 33.1 | 0.905 | 0.0273 |

Water and Ether.

| Millimols. per liter. $H_2O$ layer ($C_1$). | $(C_2H_5)_2O$ layer ($C_2$). | $\frac{C_2}{C_1}$. |
|---|---|---|
| 0.70625 | 0.1875 | 0.268 |
| 1.300 | 0.34375 | 0.264 |
| 3.0875 | 0.9125 | 0.296 |
| 6.40 | 1.875 | 0.292 |
| 11.90 | 3.65 | 0.306 |

Acetone and Glycerol.

| Millimols. per liter. Acetone layer (A). | Glycerol layer (G). | $\frac{A}{G}$. |
|---|---|---|
| 0.775 | 0.875 | 0.885 |
| 1.350 | 1.55 | 0.870 |
| 2.575 | 2.950 | 0.874 |
| 2.60 | 3.025 | 0.860 |
| 8.15 | 9.65 | 0.845 |

**DI METHYL MALONIC ACID** $C(CH_3)_2(COOH)_2$.

DISTRIBUTION OF DIMETHYL MALONIC ACID AT 25° BETWEEN WATER AND:
(Kolossowsky and Pomomarev, 1934; Kolossowsky, Kulikow and Bekturow, 1935.)

Ethyl Ether.

| Gm. Mols. $C(CH_3)_2(COOH)_2$ per liter $H_2O$ layer(1) | Ether layer(2) | $\frac{1}{2}$ |
|---|---|---|
| 0.00404 | 0.00387 | 1.044 |
| 0.00789 | 0.00831 | 0.950 |
| 0.02617 | 0.03385 | 0.773 |
| 0.0800 | 0.1233 | 0.649 |
| 0.1317 | 0.2120 | 0.621 |
| 0.2677 | 0.4396 | 0.551 |
| 0.4125 | 0.8544 | 0.483 |
| 0.5920 | 1.3978 | 0.424 |
| 0.8401 | 2.0975 | 0.401 |
| 1.1152 | 2.8877 | 0.386 |
| 1.6800 | 3.9403 | 0.426 |
| 2.3130 | 4.5236 | 0.511 |
| 3.4247 | 5.2234 | 0.656 |

Amyl Alcohol

| Gm. Mols. $C(CH_3)_2(COOH)_2$ per liter $H_2O$ layer(1) | Alcohol layer(2) | $\frac{1}{2}$ |
|---|---|---|
| 0.0043 | 0.0141 | 0.305 |
| 0.0082 | 0.0353 | 0.232 |
| 0.0171 | 0.0781 | 0.219 |
| 0.0349 | 0.1688 | 0.207 |
| 0.0688 | 0.3302 | 0.208 |
| 0.1142 | 0.5161 | 0.221 |
| 0.2510 | 1.0208 | 0.246 |
| 0.5433 | 1.8227 | 0.298 |
| 0.6884 | 2.1285 | 0.323 |
| 0.8694 | 2.3385 | 0.372 |
| 1.3118 | 3.0803 | 0.426 |
| 1.8033 | 3.5647 | 0.506 |
| 2.8852 | 4.3594 | 0.622 |

Freezing-point data for mixtures of Dimethyl Malonate and Trichloro Acetic Acid are given by Kendall and Booge, 1916.

**ETHYL MALONIC ACID** $CH(C_2H_5)(COOH)_2$.

100 gms. $H_2O$ dissolve 170.9 gms. $CH(C_2H_5)(COOH)_2$ at 25°.
" " Ethyl Ether dissolved 0.015 gm. $CH(C_2H_5)(COOH)_2$ at 25°.
(Verkade and Coops, 1930a.)

Pyro**TARTARIC ACID** (Methyl Succinic Acid) $CH_3.CH(COOH).CH_2(COOH)$.

100 gms. $H_2O$ dissolve 51 gms. $CH_3CH(COOH).CH_2COOH$ at 19.5°.
(Timofeiew, 1894.)

SOLUBILITY OF PYRO TARTARIC ACID IN ALCOHOLS.
(Timofeiew, 1894.)

| Alcohol. | t°. | Gms. Acid per 100 Gms. Solvent. | Alcohol. | t°. | Gms. Acid per 100 Gms. Solvent. |
|---|---|---|---|---|---|
| Methyl Alcohol | −18.5 | 53 | Ethyl Alcohol | 19.5 | 72.4 |
| " | +19 | 109.8 | Propyl Alcohol | 19 | 44.9 |
| " | +19.5 | 112.5 | " | 19.5 | 47.1 |
| Ethyl Alcohol | +19 | 70.8 | | | |

100 gms. 95% formic acid dissolve 17.8 gms. pyrotartaric acid at 18.5°.
(Aschan, 1913.)

**TETRANITRO PENTA ERYTHRITOL** $C(CH(NO_2)OH)_4$(?).

SOLUBILITY OF TETRANITRO PENTAERYTHRITOL IN SEVERAL SOLVENTS.
(Urbanski and Kwiatkowski, 1933a.)

| t° | Gms. $C(CH(NO_2)OH)_4$ per 100 gms. | | | | | |
|---|---|---|---|---|---|---|
| | $CH_3OH$ | $C_2H_5OH$ | $(C_2H_5)_2O$ | $(CH_3)_2CO$ | $C_6H_6$ | $C_6H_5CH_3$ |
| 0 | 0.190 | 0.070 | 0.200 | 14.37 | 0.150 | 0.150 |
| 10 | 0.235 | 0.085 | 0.225 | 16.43 | — | 0.170 |
| 20 | 0.455 | 0.195 | 0.250 | 20.26 | 0.300 | 0.230 |
| 30 | 0.710 | 0.275 | 0.340 | 24.95 | 0.450 | 0.430 |
| 40 | 1.160 | 0.415 | 0.450(34.7°) | 30.56 | 1.160 | 0.620 |
| 50 | 1.840 | 0.705 | — | 36.16 | 2.010 | 1.100 |
| 60 | 2.600 | 1.205 | — | 42.68(62.0°) | 3.350 | 2.490 |
| 70 | 3.235(65.1°) | 2.225 | — | — | 5.400 | 3.290 |
| 80 | — | 3.795(78.4°) | — | — | 7.900(80.2°) | 5.850 |
| 90 | — | — | — | — | — | 9.120 |
| 100 | — | — | — | — | — | 15.920 |
| 113 | — | — | — | — | — | 30.960 |

Freezing-point data are given by Urbanski, 1933, 1934, for mixtures of Nitro Penta Erythritol and each of the following compounds: Diphenyl amine, diethyl diphenyl urea, dimethyl diphenyl urea, m dinitro benzene, 1.2.4 dinitro toluene, 1.2.4 Chloro dinitro benzene 1.3.5 dinitro anisole, nitro erythrite, naphthalene, p nitro anisole, nitro mannite, α nitro naphthalene, p nitro toluene, 1.3.5 trinitro benzene, 2.4.6 trinitro toluene, trinitro phenyl, methyl nitramine. (tetryl)

**VALERONITRILE** $CH_3(CH_2)_3CN$.

Freezing-point data for mixtures of valeronitrile and each of the following compounds: Acetonitrile, Proprionitrile and Benzene are given by Joukovsky, 1934.

**α BROMO VALERIC ACID** $CH_3(CH_2)_2CHBrCOOH$.
**α BROMO ISO VALERIC ACID** $(CH_3)_2CHCHBrCOOH$.

DISTRIBUTION OF α BROMO n VALERIC ACID AT 25° BETWEEN:
(Smith and White, 1929.)

| Water and Benzene | | Water and Toluene | |
|---|---|---|---|
| Gm. Mols. $C_5H_9O_2Br$ per liter | | Gm. Mols. $C_5H_9O_2Br$ per liter | |
| $H_2O$ layer | $C_6H_6$ layer | $H_2O$ layer | $C_6H_5CH_3$ layer |
| 0.00475 | 0.01042 | 0.00470 | 0.00790 |
| 0.00601 | 0.01496 | 0.00605 | 0.01146 |
| 0.00718 | 0.02012 | 0.00758 | 0.01731 |
| 0.00783 | 0.02357 | 0.00882 | 0.02258 |
| 0.00879 | 0.02862 | 0.00980 | 0.02760 |
| 0.01071 | 0.04119 | 0.01195 | 0.03995 |
| 0.01285 | 0.05625 | 0.01430 | 0.05480 |

DISTRIBUTION OF α BROMO VALERIC ACID AND OF α BROMO ISO VALERIC ACID BETWEEN WATER AND OLIVE OIL AT 25°.
(Bodansky and Meigs, 1932.)

Results for:

| α Bromo Valeric Acid | | | | α Bromo Iso Valeric Acid | | | |
|---|---|---|---|---|---|---|---|
| t° | Gm. Mols. $C_5H_9O_2Br$ per liter | | $\frac{1}{2}$ | t° | Gm. Mols. $C_5H_9O_2Br$ per liter | | $\frac{1}{2}$ |
| | $H_2O$ layer(1) | Oil layer(2) | | | $H_2O$ layer(1) | Oil Layer(2) | |
| 25 | 0.0048 | 0.017 | 0.283 | 25 | 0.0032 | 0.0060 | 0.532 |
| " | 0.0103 | 0.042 | 0.245 | " | 0.0053 | 0.0140 | 0.379 |
| " | 0.0200 | 0.086 | 0.233 | " | 0.0130 | 0.0400 | 0.325 |
| 37.5 | 0.0045 | 0.017 | 0.265 | " | 0.0222 | 0.0840 | 0.265 |
| " | 0.0102 | 0.042 | 0.243 | 37.5 | 0.0063 | 0.0140 | 0.45 |
| " | 0.0190 | 0.085 | 0.223 | " | 0.0120 | 0.0390 | 0.308 |
| | | | | " | 0.0222 | 0.0830 | 0.268 |

**HYDROXY PROLINE** $C_4H_7N(OH)COOH$.

100 cc 99-100% Acetic Acid dissolves 1.67 gm. $C_5H_9O_3N$ at 18°.
100 cc pure Butyric Acid " 0.006 " " " "
(v. Przylecki and Kasprzyk-Czaykowska, 1938.)

**FORMYL α AMINO BUTYRIC ACID** $CH_3CH_2CH(NHCHO)COOH$.

SOLUBILITY IN AQUEOUS SOLUTIONS OF ETHYL ALCOHOL AT 25°.
(McMeekin, Cohn and Weare, 1935.)

| Vol. % $C_2H_5OH$ in Aq. Solvent | d. of sat. sol. | Gm. Mols. $C_5H_9O_3N$ per liter sat. sol. | Vol. % $C_2H_5OH$ in Aq. Solvent | d. of sat. sol. | Gm. Mols. $C_5H_9O_3N$ per liter sat. sol. |
|---|---|---|---|---|---|
| 0.0(= $H_2O$) | 1.0043 | 0.256 | 80 | 0.8812 | 0.691 |
| 20 | 0.9816 | 0.313 | 90 | 0.8492 | 0.586 |
| 40 | 0.9600 | 0.475 | 100 | 0.8018 | 0.355 |
| 60 | 0.9297 | 0.666 | | | |

One liter sat. sol. in Methanol contain 0.646 gm. mol. $C_5H_9O_3N$ at 25° and d. of sat. sol. = 0.8222.
One liter sat. sol. in Heptanol contain 0.050 gm. mol. $C_5H_9O_3N$ at 25° and d. of sat. sol. = 0.82473. (McMeekin, Cohn and Weare, 1936.)

## GLUTAMIC ACID d $COOH(CH_2)_2CH(NH_2)COOH$.

### Solubility of d Glutamic Acid in Water.
(Dalton and Schmidt, 1933.)

The following values were derived from a solubility equation based upon 35 very careful determinations made at 9 temperatures between 0° and 60°. The density of a 0.9399 percent aqueous d glutamic acid solution is 1.00068 at 25°.

| t° | Gms. $C_5H_9O_4N$ per 100 gms. $H_2O$ | t° | Gms. $C_5H_9O_4N$ per 100 gms. $H_2O$ | t° | Gms. $C_5H_9O_4N$ per 100 gms. $H_2O$ |
|---|---|---|---|---|---|
| 0 | 0.341(0.345) | 30 | 1.040 | 60 | 3.169 |
| 5 | 0.411 | 35 | 1.252 | 65 | 3.816 |
| 10 | 0.495 | 40 | 1.508 | 70 | 4.594 |
| 15 | 0.596 | 45 | 1.816 | 75 | 5.532(5.34) |
| 20 | 0.717 | 50 | 2.186(2.228) | 100 | 14.00 |
| 25 | 0.864(0.8852) | 55 | 2.632 | | |

The results in parentheses are by Dunn, Ross and Reed, 1933.

One very careful determination at 25° by Pertzoff, 1933, gave 0.87 gms. $C_5H_7O_4N$ per 100 cc sat. solution.

One liter of water saturated with d Glutamic acid at 25° contains 0.0585 gm. mol. $C_5H_9O_4N$ and the density = 1.0002. (McMeekin, Cohn and Weare, 1935.)

### Solubility of Glutamic Acid in Water and in Aqueous Salt Solutions.

| Solvent. | t°. | Gms. $C_3H_5(NH_2)(COOH)_2$ per 100 cc. sat. sol. | Authority. |
|---|---|---|---|
| Water..... | 20 | 0.669 | (Pfeiffer and Würgler, 1916.) |
| » ..... | 21 | 0.658 | (Pfeiffer and Angern, 1924.) |
| Aq. 2.01 *n* Li Cl solution.... | 20 | 0.707 | (Pfeiffer and Würgler, 1916.) |
| » 2.00 *n* K Cl » .... | 20 | 0.878 | » |
| » 2.00 *n* $KNO_3$ » .... | 20 | 1.205 | » |

## GLUTAMIC ACID dl $COOH(CH_2)_2CH(NH_2)COOH$.

### Solubility of dl Glutamic Acid in Water.
(Dalton and Schmidt, 1933.)

The following values were derived from a solubility equation based upon 24 very careful determinations made at 9 temperatures between 0° and 65°. The density of a 2.111 percent aqueous solution is 1.00529.

| t° | Gms. $C_5H_9O_4N$ per 100 gms. $H_2O$ | t° | Gms. $C_5H_9O_4N$ per 100 gms. $H_2O$ | t° | Gms. $C_5H_9O_4N$ per 100 gms. $H_2O$ |
|---|---|---|---|---|---|
| 0 | 0.855(0.831) | 30 | 2.447 | 60 | 7.006 |
| 5 | 1.018 | 35 | 2.916 | 65 | 8.350 |
| 10 | 1.213 | 40 | 3.475 | 70 | 9.950 |
| 15 | 1.446 | 45 | 4.141 | 75 | 11.86 (19.9 |
| 20 | 1.722 | 50 | 4.934(8.165) | 100 | 28.49 |
| 25 | 2.054(2.643) | 55 | 5.880 | | |

The results in parentheses are by Dunn, Ross and Reed, 1933.

### Solubility of d Glutamic Acid in Aqueous Ethyl Alcohol.
(Dunn and Ross, 1936.)

| t° | Wt. % $C_2H_5OH$ in aqueous solvent | d. of sat. sol. | Gms. $C_5H_9O_4N$ per 100 gms. solvent | t° | Wt. % $C_2H_5OH$ in aqueous solvent | d. of sat. sol. | Gms. $C_5H_9O_4N$ per 100 gms. solvent |
|---|---|---|---|---|---|---|---|
| 0.0 | 20.16 | 0.971 | 0.0855 | 25 | 100 | 0.783 | 0.0025 |
| " | 42.59 | 0.934 | 0.0371 | 45 | 20 | 0.960 | 0.811 |
| " | 67.03 | 0.882 | 0.0163 | 45.3 | 42.59 | 0.912 | 0.378 |
| 25.0 | 20.00 | 0.964 | 0.292 | 44.9 | 67.11 | 0.854 | 0.0885 |
| " | 42.66 | 0.925 | 0.131 | 45.2 | 92.61 | 0.794 | 0.0127 |
| " | 67.11 | 0.867 | 0.037 | 44.9 | 100.0 | 0.770 | 0.0056 |
| " | 92.61 | 0.807 | 0.0044 | | | | |

10 cc. of a cold aqueous sat. solution of $Mg(ClO_4)_2$ dissolve 1.25 gm. d Glutamic Acid. (Duclaux and Durand-Gasselin, 1938.)

### Solubility of d Glutamic in Several Solvents at 25°.
(Pertzoff, 1933.)

| Solvent | Gm. $C_5H_9O_4N$ per 100cc sat. sol. | Gm. Mols. $C_5H_9O_4N$ per 1000 gms. solvent |
|---|---|---|
| Methyl Alcohol | 0.0058 | 0.00048 |
| Ethyl Alcohol | 0.0054 | 0.00046 |
| Acetone | 0.0006 | 0.0000025 |

## GLUTAMIC ACID HYDROCHLORIDE $C_3H_5NH_2(COOH)_2.HCl$.

### Solubility in Water. (Stoltzenberg, 1912.)

(The following results were taken from the diagram given by the author.)

| t°. | Gms. Glutamic. Acid. HCl per 100 cc. Sat. Sol. | t°. | Gms. Glutamic Acid. HCl per 100 cc. Sat. Sol. |
|---|---|---|---|
| 0 | 31.5 | 60 | 57 |
| 10 | 34.5 | 70 | 62 |
| 20 | 38 | 80 | 67.5 |
| 30 | 42.5 | 90 | 74 |
| 40 | 47 | 100 | 81 |
| 50 | 52 | 20 | 1.4 (sol. sat. with HCl) |

## DIGLYCINE HYDANTOIC ACID $C_5H_9O_4N_3$.

### Solubility of Diglycine Hydantoic Acid in Aqueous Ethyl Alcohol at 25°.
(McMeekin, Cohn and Weare, 1936.)

| Solvent | d. of sat. sol. | Gm. Mols. $C_5H_9O_4N_3$ per liter |
|---|---|---|
| Water | 1.0050 | 0.126 |
| 80% $C_2H_5OH$ | 0.85695 | 0.0220 |
| 90% " | 0.82564 | 0.00851 |
| 100% " | 0.7857 | 0.00115 |

**AMYLENE** (1-Pentene?) $C_5H_{10}$.

5.0 cc of an aqueous sat. solution of sodium salicylate dissolve 0.05 cc of Amylene at about 18°. (Traube, Schöning and Weber, 1927.)

CRITICAL TEMPERATURE OF VAPORIZATION OF MIXTURES OF AMYLENE AND LIQUID CARBON DIOXIDE.
(Büchner, 1905-06.)

The determinations were made by the synthetic method.

| | | | |
|---|---|---|---|
| t° (Crit.) | 31 | 103 | 201 |
| Gms. $C_5H_{10}$ per 100 gms. mixture | 0 | 38 | 100 |

**AMYLENE** (Trimethylethylene) $(CH_3)_2C:CHCH_3$.

RECIPROCAL SOLUBILITY IN ANILINE; DETERMINATIONS BY SYNTHETIC METHOD.
(Konowalow, 1903.)

| t°. | Gms. Aniline per 100 Gms. Amylene Layer. | Aniline Layer. | t°. | Gms. Aniline per 100 Gms. Amylene Layer. | Aniline Layer. |
|---|---|---|---|---|---|
| 0 | 19.5 | 81.5 | 10 | 28 | 73 |
| 2 | 19.7 | 80.5 | 12 | 34 | 68 |
| 4 | 20.5 | 79.5 | 13 | 38.5 | 64.7 |
| 6 | 21.7 | 78 | 14 | 45 | 59 |
| 8 | 24.2 | 75.8 | 14.5 (crit. temp.) | 51.6 | |

**METHYL n PROPYL KETONE** (2-Pentanone) $CH_3CO(CH_2)_2CH_3$.

100 gms. sat. sol. of Methyl Propyl Ketone in Water contain 6.0 gms. $(CH_3)(C_3H_7)CO$ at approximately 25°.
100 gms. sat. sol. of Water in Methyl Propyl Ketone contain 3.6 gms $H_2O$ at approximately 25°. (Park and Hofman, 1932.)

SOLUBILITY OF METHYL n PROPYL KETONE AND OF METHYL ISO PROPYL KETONE, EACH SEPARATELY, IN WATER.
(Gross, Rintelen and Saylor, 1939.)

| t° | Gm. Mols. normal $C_5H_{10}O$ per 100 gms. $H_2O$ | Gms. Iso $C_5H_{10}O$ per 100 gms. $H_2O$ |
|---|---|---|
| 10 | 0.887 | 0.813 |
| 30 | 0.630 | 0.608 |
| 50 | 0.515 | 0.594 |

**DIETHYL KETONE** (Propione) $(C_2H_5)_2CO$.

SOLUBILITY IN WATER. (Rothmund, 1898.)

The determinations were made by Synthetic Method, see p. 292 The critical temperature could not be reached and high accuracy is not claimed for the results.

| t°. | Gms. Diethyl Ketone per 100 Gms. Aq. Layer. | Ketone Layer. | t°. | Gms. Diethyl Ketone per 100 Gms. Aq. Layer. | Ketone Layer. |
|---|---|---|---|---|---|
| 20 | 4.60 | ... | 100 | 3.68 | 93.10 |
| 40 | 3.43 | 97.42 | 120 | 4.05 | 90.18 |
| 60 | 3.08 | 96.18 | 140 | 4.76 | 87.01. |
| 80 | 3.20 | 94.92 | 160 | 6.10 | 83.33 |

## Solubility of Diethyl Ketone in Water.

(Gross, Saylor and Gorman, 1933; Gross, Rintelen and Saylor, 1939.)

| t° | Gm. Mols. $C_5H_{10}O$ per 1000 gms. $H_2O$ | Gms. $C_5H_{10}O$ per 100 gms. $H_2O$ |
|---|---|---|
| 10 | 0.781 | 6.73 |
| 30 | 0.576 | 4.96 |
| 50 | 0.456 | 3.93 |

Results for the partial vapor pressures at 30° of Diethyl ketone in aqueous solution less than saturated are given by Saylor, Stuckey and Gross, 1938.

## Reciprocal Solubilities of Several Pentanols and Water.

(Ginnings, Herring and Coltrane, 1939.)

| Alcohol | Formula | t° | Gms. alcohol per 100 gms. sat. sol. in $H_2O$ | Gms. $H_2O$ per 100 gms. sat. sol. in alcohol |
|---|---|---|---|---|
| 3 Penten - 2 ol | $C_5H_{10}O$ | 20 | 9.46 | 12.29 |
| " " | " | 25 | 8.92 | 12.35 |
| " " | " | 30 | 8.48 | 12.43 |
| 4 Penten - 3 ol | $C_5H_{10}O$ | 20 | 8.72 | 12.88 |
| " " | " | 25 | 8.20 | 13.12 |
| " " | " | 30 | 7.74 | 13.22 |
| 4 Penten - 1 ol | $C_5H_{10}O$ | 20 | 5.89 | 13.17 |
| " " | " | 25 | 5.70 | 13.43 |
| " " | " | 30 | 5.56 | 13.81 |

## Reciprocal Solubilities of Several Cyclic Ethers and Water.

(Bennett and Philip, 1928.)

The authors used a modification of the method of Hill, 1923, in which the size of the vessels were greatly reduced and a globule of Hg was introduced to hasten the mixing of the phases.

| Cyclic Ether | Formula | t° | Gms. Ether per 100 gms. sat. sol. in $H_2O$ | Gms. $H_2O$ per 100 gms. sat. sol. in ether |
|---|---|---|---|---|
| Penta methylene oxide | $C_5H_{10}O$ | 0 | 13.40 | 1.63 |
| " " " | " | 10 | 10.70 | 2.08 |
| " " " | " | 15 | 9.64 | 2.27 |
| " " " | " | 20 | 8.76 | 2.70 |
| " " " | " | 25 | 8.02 | 3.14 |
| α Methyl tetra methylene oxide | $C_5H_{10}O$ | 0 | 22.10 | 9.54 |
| " " " " | " | 10 | 18.20 | 7.72 |
| " " " " | " | 15 | 16.52 | 7.05 |
| " " " " | " | 20 | 15.05 | 6.65 |
| " " " " | " | 25 | 13.87 | 6.08 |
| β Methylene tetra methylene oxide | $C_5H_{10}O$ | 0 | 14.6 | — |
| " " " " | " | 10 | 11.25 | — |
| " " " " | " | 15 | 10.2 | — |
| " " " " | " | 20 | 9.5 | — |
| " " " " | " | 25 | 8.8 | — |
| ββ′ Dimethyl trimethylene | $C_5H_{10}O$ | 0 | 23.28 | 13.96 |
| " " | " | 10 | 19.31 | 12.15 |
| " " | " | 15 | 17.71 | 11.32 |
| " " | " | 20 | 16.26 | 10.67 |
| " " | " | 25 | 15.04 | 10.20 |

## BUTYL FORMATE $HCOOC_4H_9$.

### Solubility of Butyl Formate in Aqueous Ethyl Alcohol Mixtures.

(Pfeiffer, 1892; Bancroft, 1895.)

| Composition of Homogeneous Mixture | | | Composition of Homogeneous Mixture | | |
|---|---|---|---|---|---|
| cc. $HCOOC_4H_9$ | cc. $C_2H_5OH$ | cc $H_2O$ | cc. $HCOOC_4H_9$ | cc. $C_2H_5OH$ | cc. $H_2O$ |
| 3.0 | 3.0 | 3.45 | 3.0 | 15.0 | 29.65 |
| 3.0 | 6.0 | 8.83 | 3.0 | 18.0 | 39.0 |
| 3.0 | 9.0 | 14.75 | 3.0 | 21.0 | 51.8 |
| 3.0 | 12.0 | 21.45 | 3.0 | 24.0 | ∞ |

100 gms. $H_2O$ dissolve 1.0 gm. Iso butyl formate at 22°. (Traube, 1884.)

## PROPYL ACETATE $CH_3COOC_3H_7$.

100 cc $H_2O$ dissolve 1.93 gms. $CH_3COOC_3H_7$ at 20°. (Führer, 1924.)
100 cc $H_2O$ dissolve 1.7 gm. $CH_3COOC_3H_7$ at 22°. (Traube, 1884.)
100 cc $H_2O$ dissolve 3.19 gms. Iso Propyl Acetate at 20°. (Führer, 1924.)

### Equilibrium in the System Propyl Acetate, Ethyl Alcohol and Water at Room Temperature.

(Pfeiffer, 1892; Bancroft, 1895.)

| Composition of Homogeneous Mixtures | | | Composition of Homogeneous Mixtures | | |
|---|---|---|---|---|---|
| cc $CH_3COOC_3H_7$ | cc $C_2H_5OH$ | cc $H_2O$ | cc $CH_3COOC_3H_7$ | cc $C_2H_5OH$ | cc $H_2O$ |
| 3.0 | 3.0 | 4.5 | 3.0 | 15.0 | 35.63 |
| 3.0 | 6.0 | 10.48 | 3.0 | 18.0 | 47.50 |
| 3.0 | 9.0 | 17.80 | 3.0 | 21.0 | 58.71 |
| 3.0 | 12.0 | 26.00 | 3.0 | 24.0 | ∞ |

## ETHYL PROPIONATE $C_2H_5COOC_2H_5$.

### Solubility in Water and in Aqueous Ethyl Alcohol Mixtures.

(Pfeiffer, 1892; Bancroft, 1895.)

| cc. Alcohol in Mixture. | cc. $H_2O$ to Cause Separation of a Second Phase in Mixtures of the Given Amounts of Alcohol and 3 cc. Portions of Ethyl Propionate. |
|---|---|
| 3 | 2.32 |
| 6 | 6.87 |
| 9 | 12.35 |
| 12 | 19.17 |
| 15 | 27.12 |
| 18 | 36.84 |
| 21 | 50.42 |
| 24 | ∞ |

100 grams $H_2O$ dissolve 1.7 grams ethyl propionate at 22°. (Traube, 1884.)

Freezing-point data for mixtures of ethyl propionate and ethyl formate are given by Timmermans, 1934.

## METHYL BUTYRATE $C_3H_7COOCH_3$.

100 gms. $H_2O$ dissolve 1.7 gms. $C_3H_7COOCH_3$ at 22°. (Traube, 1884.)
100 gms. sat. solution of methyl butyrate in water contain 1.792 cc $C_3H_7COOCH_3$ (= 1.559 gm.) at 21°. (Führer, 1924.)

$C_5H_{10}O_2$

**VALERIC ACID** *n* $CH_3(CH_2)_3COOH$ (*n* Propyl Acetic Acid).

When valeric acid is shaken with water at 16°, two layers are formed.
100 gms. of the aqueous layer contain 3.4 gms. $CH_3(CH_2)_3COOH$.
100 gms. of the acid layer contain 90.4 gms. $CH_3(CH_2)_3COOH$.
(Lieben and Rossi, 1871.)

### Distribution of Valeric Acid between Benzene and 95.8% Sulfuric Acid.

(Gurwitsch, 1914.)

The mixtures were made at 0° and brought to equilibrium by shaking for 5 minutes at 18°, and allowing to stand over night.

| Gms. Valeric Acid per 100 Gms. | | Gms. Valeric Acid per 100 Gms. | |
|---|---|---|---|
| Benzene Layer. | $H_2SO_4$ Layer. | Benzene Layer. | $H_2SO_4$ Layer. |
| 7.60 | 46.4 | 1 | 36.7 |
| 4.78 | 44.8 | 0.58 | 35.2 |
| 3.64 | 43.5 | 0.29 | 32.7 |
| 2.61 | 41.4 | 0.20 | 30.7 |
| 1.62 | 39.5 | 0.04 | 26.1 |
| 1.48 | 38.1 | 0.007 | 23.8 |

The coefficient of distribution of isovaleric acid between benzene and water at room temperature is, conc. in $C_6H_6$ ÷ conc. in $H_2O$ = 2.744. (King and Narracott 1909.)

**VALERIC ACID** *n* $CH_3(CH_2)_3COOH$.

### Distribution of Valeric Acid Between :

#### Water and Benzene at 22°.
(Brown and Bury, 1923.)

| Normality of $CH_3(CH_2)_3COOH$ in | |
|---|---|
| $H_2O$ layer. | $C_6H_6$ layer |
| 0.1357 | 1.848 |
| 0.1149 | 1.400 |
| 0.0919 | 0.929 |
| 0.0610 | 0.445 |
| 0.0479 | 0.289 |

| Normality of $CH_3(CH_2)_3COOH$ in | |
|---|---|
| $H_2O$ layer. | $C_6H_6$ layer. |
| 0.0383 | 0.191 |
| 0.0235 | 0.0793 |
| 0.0178 | 0.0481 |
| 0.0136 | 0.0292 |

#### Water and Chloroform at 25°.
(Smith, 1921, 1922.)

| Millimols. $CH_3(CH_2)_3COOH$ per liter of | | |
|---|---|---|
| $H_2O$ layer ($C_1$). | $CHCl_3$ layer ($C_2$). | $\frac{C_2}{C_1}$. |
| 0.890 | 0.70 | 1.80 |
| 0.650 | 1.35 | 2.08 |
| 0.910 | 2.00 | 2.20 |
| 1.825 | 4.625 | 2.53 |

### Distribution of Valeric Acid Between Water and Ethyl Ether.

#### Results at 22°.
(Behrens, 1926.)

| Concentration in | | | Concentration in | | |
|---|---|---|---|---|---|
| $H_2O$ layer ($C_1$). | $(C_2H_5)_2O$ layer ($C_2$). | $\frac{C_2}{C_1}$. | $H_2O$ layer ($C_1$). | $(C_2H_5)_2O$ layer ($C_2$). | $\frac{C_2}{C_1}$. |
| 0.00315 | 0.0675 | 21.4 | 0.01015 | 0.2358 | 23.2 |
| 0.00413 | 0.0907 | 21.9 | 0.0161 | 0.4025 | 25.1 |
| 0.00507 | 0.1145 | 22.6 | 0.0164 | 0.4155 | 25.3 |
| 0.00671 | 0.1528 | 22.8 | | | |

#### Results at 25°.
(Smith, 1921, 1922.)

| Millimols. per liter in | | |
|---|---|---|
| $H_2O$ layer ($C_1$). | $(C_2H_5)_2O$ layer ($C_2$). | $\frac{C_2}{C_1}$. |
| 0.0775 | 1.0225 | 13.20 |
| 0.1125 | 1.4575 | 12.92 |
| 0.1700 | 2.2000 | 12.95 |
| 0.3000 | 4.3000 | 14.32 |
| 0.3900 | 5.6700 | 15.52 |

### Distribution of Valeric Acid at 25° Between Water and Xylene.
(Smith, 1921, 1922.)

| Millimols. $CH_3(CH_2)_3COOH$ per liter. | | |
|---|---|---|
| $H_2O$ layer ($C_1$). | $C_6H_4(CH_3)_2$ layer ($C_2$). | $\frac{C_2}{C_1}$. |
| 0.6625 | 0.3125 | 0.472 |
| 1.150 | 0.625 | 0.543 |
| 1.500 | 0.925 | 0.616 |
| 2.175 | 1.575 | **0.725** |

| Millimols. $CH_3(CH_2)_3COOH$ per liter | | |
|---|---|---|
| $H_2O$ layer ($C_1$). | $C_6H_4(CH_3)_2$ layer ($C_2$). | $\frac{C_2}{C_1}$. |
| 2.30 | 1.70 | 0.74 |
| 5.00 | 5.00 | 1.00 |
| 8.40 | 11.6 | 1.38 |

## Distribution of Normal Valeric Acid at 25° Between Water and:
(Smith and White, 1929.)

| Chloroform | | Benzene | | Toluene | |
|---|---|---|---|---|---|
| Gm. Mols. $C_5H_{10}O_2$ per liter | | Gm. Mols. $C_5H_{10}O_2$ per liter | | Gm. Mols. $C_5H_{10}O_2$ per liter | |
| $H_2O$ layer | $CHCl_3$ layer | $H_2O$ layer | $C_6H_6$ layer | $H_2O$ layer | $C_6H_5CH_3$ layer |
| 0.00228 | 0.00664 | 0.00150 | 0.00144 | 0.00132 | 0.000979 |
| 0.00321 | 0.01055 | 0.00454 | 0.00706 | 0.00195 | 0.00168 |
| 0.00437 | 0.01723 | 0.00655 | 0.01247 | 0.00491 | 0.00668 |
| 0.00602 | 0.02818 | 0.01041 | 0.02679 | 0.00711 | 0.01192 |
| 0.00770 | 0.04200 | 0.01440 | 0.04649 | 0.01546 | 0.04543 |
| 0.00917 | 0.05433 | 0.01981 | 0.08254 | 0.02160 | 0.08075 |
| 0.01040 | 0.06900 | 0.02661 | 0.14079 | 0.02889 | 0.1385 |

## Distribution of Valeric Acid at 25° Between Water and Several Organic Solvents.
(Archibald, 1932.)

| Organic Solvent | Formula | Gm. Mols. $C_5H_{10}O_2$ per liter | | $\frac{2}{1}$ |
|---|---|---|---|---|
| | | $H_2O$ layer(1) | Organic layer(2) | |
| Methyl Ethyl Ketone | $CH_3COC_2H_5$ | 0.03157 | 0.32236 | 10.211 |
| ter. Amyl Alcohol | $C_5H_{11}OH$ | 0.01197 | 0.33074 | 27.631 |
| Sec. Butyl Alcohol | $C_4H_9OH$ | 0.02742 | 0.31139 | 11.356 |
| n " " | $C_4H_9OH$ | 0.01371 | 0.31550 | 23.012 |
| n Amyl " | $C_5H_{11}OH$ | 0.00883 | 0.31288 | 35.43 |
| Ethyl Ether | $(C_2H_5)_2O$ | — | — | 17.5 |

## Distribution of Valeric Acid at Room Temperature Between Water and Petroleum Ether.
Grossfeld, and Miermeister, 1931.)

| cc 0.1n NaOH per 25 cc of: | | $\frac{1}{2}$ |
|---|---|---|
| $H_2O$ layer(1) | Pet. Ether layer(2) | |
| 0.58 | 0.08 | 7.25 |
| 1.92 | 0.82 | 2.34 |
| 5.86 | 7.09 | 0.83 |
| 9.56 | 18.93 | 0.50 |
| 13.70 | 39.05 | 0.35 |

## Distribution of Normal Valeric Acid and of Iso Valeric Acid Between Water and Olive Oil at 25°.
(Bodansky and Meigs, 1932; Bodansky, 1928.)

### Normal Valeric Acid

| t° | Gm. Mol. $C_5H_{10}O_2$ per liter | | $\frac{1}{2}$ |
|---|---|---|---|
| | $H_2O$ layer(1) | Oil layer(2) | |
| 25 | 0.0026 | 0.0070 | 0.371 |
| " | 0.0058 | 0.0140 | 0.415 |
| " | 0.0137 | 0.0350 | 0.392 |
| " | 0.0260 | 0.0700 | 0.372 |
| 37 | 0.0013 | 0.0035 | 0.371 |
| " | 0.0026 | 0.0070 | 0.371 |
| " | 0.0055 | 0.0140 | 0.393 |
| " | 0.0135 | 0.0350 | 0.385 |
| " | 0.0260 | 0.0714 | 0.365 |

### Iso.Valeric Acid

| t° | Gm. Mol. $\frac{1}{2}$ $C_5H_{10}O_2$ per liter | | $\frac{1}{2}$ |
|---|---|---|---|
| | $H_2O$ layer(1) | Oil layer (2) | |
| 25 | 0.0070 | 0.0122 | 0.574 |
| " | 0.0167 | 0.0320 | 0.522 |
| " | 0.0320 | 0.0688 | 0.465 |
| 37.5 | 0.0035 | 0.0060 | 0.583 |
| " | 0.0071 | 0.0122 | 0.582 |
| " | 0.0170 | 0.0320 | 0.532 |
| " | 0.0318 | 0.0688 | 0.465 |

## Iso VALERIC ACID $(CH_3)_2.CH.CH_2COOH$.

### Solubility of Iso Valeric Acid in Aqueous Solutions of Phosphoric Acid at 25°.

(Walton and Kepfer, 1930.)

| Normality of aq. $H_3PO_4$ | Normality of dissolved $C_5H_{10}O_2$ | Normality of aq. $H_3PO_4$ | Normality of dissolved $C_5H_{10}O_2$ | Normality of aq. $H_3PO_4$ | Normality of dissolved $C_5H_{10}O_2$ |
|---|---|---|---|---|---|
| 0.0 | 0.467 | 19.43 | 0.15 | 35.72 | 0.15 |
| 7.67 | 0.26 | 28.39 | 0.10 | 39.15 | 0.21 |
| 13.84 | 0.18 | 32.16 | 0.11 | 42.82 | 0.39 |

### Distribution of Iso Valeric Acid Between Water and Chloroform at 25°. (Smith, 1921, 1922.)

| Millimols. per liter in $H_2O$ layer ($C_1$). | Millimols. per liter in $CHCl_3$ layer ($C_2$). | $\frac{C_2}{C_1}$. |
|---|---|---|
| 1.239 | 1.162 | 0.94 |
| 1.585 | 1.65 | 1.04 |
| 2.45 | 2.90 | 1.182 |
| 3.35 | 4.55 | 1.36 |

### Distribution of Iso Valeric Acid Between Water and Ethyl Ether at 16-17°. (Behrens, 1926.)

| Concentration in $H_2O$ layer ($C_1$). | Concentration in $(C_2H_5)_2O$ layer ($C_2$). | $\frac{C}{C_1}$. |
|---|---|---|
| 0.0051 | 0.0993 | 19.5 |
| 0.0078 | 0.1533 | 19.7 |
| 0.0125 | 0.257 | 20.5 |

### Distribution of Iso Valeric Acid Between Water and Ethyl Ether at 25°. (Smith, 1921, 1922.

| Millimols. per liter in $H_2O$ layer ($C_1$). | Millimols. per liter in $(C_2H_5)_2O$ layer ($C_2$). | $\frac{C_2}{C_1}$. |
|---|---|---|
| 0.2500 | 1.875 | 7.50 |
| 0.4437 | 3.275 | 7.70 |
| 0.5750 | 4.500 | 7.82 |
| 0.8875 | 7.087 | 7.98 |
| 1.325 | 11.00 | 8.32 |

### Distribution of Iso Valeric Acid at 25° Between: (Smith, 1921, 1922.)

#### Water and Xylene.

| Millimols. per liter in $H_2O$ layer ($C_1$). | Millimols. per liter in Xylene layer ($C_2$). | $\frac{C_2}{C_1}$. |
|---|---|---|
| 1.875 | 0.600 | 0.320 |
| 2.35 | 0.875 | 0.372 |
| 3.85 | 1.55 | 0.403 |
| 4.275 | 1.925 | 0.450 |
| 5.30 | 2.60 | 0.490 |
| 6.15 | 3.15 | 0.512 |

#### Acetone and Glycerol.

| Millimols. per liter in Acetone layer (A). | Millimols. per liter in Glycerol layer (G) | $\frac{A}{G}$. |
|---|---|---|
| 4.75 | 0.1125 | 42.3 |
| 5.15 | 0.1375 | 37.4 |
| 10.30 | 0.300 | 34.4 |
| 23.00 | 0.500 | 46.0 |

## ISO VALERIC ACID

### Distribution of Iso Valeric Acid at 25° Between Water and;

(Smith and White, 1929.)

| Chloroform: Gm. Mols. iso $C_5H_{10}O_2$ per liter $H_2O$ layer | Chloroform: Gm. Mols. iso $C_5H_{10}O_2$ per liter $CHCl_3$ layer | Benzene: Gm. Mols. iso $C_5H_{10}O_2$ per liter $H_2O$ layer | Benzene: Gm. Mols. iso $C_5H_{10}O_2$ per liter $C_6H_6$ layer | Toluene: Gm. Mols. iso $C_5H_{10}O_2$ per liter $H_2O$ layer | Toluene: Gm. Mols. iso $C_5H_{10}O_2$ per liter $C_6H_5CH_3$ layer |
|---|---|---|---|---|---|
| 0.00147 | 0.00247 | 0.00510 | 0.00526 | 0.00555 | 0.00492 |
| 0.00276 | 0.00627 | 0.00641 | 0.00747 | 0.00699 | 0.00688 |
| 0.00403 | 0.01059 | 0.00808 | 0.01082 | 0.00874 | 0.01016 |
| 0.00596 | 0.01964 | 0.01214 | 0.02154 | 0.01086 | 0.01482 |
| 0.00771 | 0.02769 | 0.01404 | 0.02771 | 0.01307 | 0.02061 |
| 0.00989 | 0.04231 | 0.01644 | 0.03229 | 0.01777 | 0.03494 |
| 0.01213 | 0.06188 | 0.01915 | 0.04805 | 0.02100 | 0.04620 |
| 0.01538 | 0.09142 | 0.02231 | 0.06254 | 0.02418 | 0.06067 |

## Distribution of Iso Valeric Acid Between Water and Benzene at Several Temperatures.

(Bektourow, 1939a.)

| Results at 0° | | | Results at 25° | | | Results at 60° | | |
|---|---|---|---|---|---|---|---|---|
| Gm. Mols. iso $C_5H_{10}O_2$ per liter | | $\frac{1}{2}$ | Gm. Mols. iso $C_5H_{10}O_2$ per liter | | $\frac{1}{2}$ | Gm. Mols. iso $C_5H_{10}O_2$ per liter | | $\frac{1}{2}$ |
| $H_2O$ layer(1) | $C_6H_6$ layer(2) | | $H_2O$ layer(1) | $C_6H_6$ layer(2) | | $H_2O$ layer(1) | $C_6H_6$ layer(2) | |
| 0.0104 | 0.0132 | 0.788 | 0.0120 | 0.0212 | 0.566 | 0.0134 | 0.0268 | 0.500 |
| 0.0170 | 0.0322 | 0.528 | 0.0245 | 0.0754 | 0.323 | 0.0211 | 0.0483 | 0.437 |
| 0.0293 | 0.0889 | 0.337 | 0.0401 | 0.1895 | 0.212 | 0.0446 | 0.2561 | 0.174 |
| 0.0587 | 0.3217 | 0.182 | 0.0669 | 0.4794 | 0.140 | 0.0647 | 0.4683 | 0.138 |
| 0.1072 | 1.0031 | 0.107 | 0.0818 | 0.7136 | 0.115 | 0.1041 | 1.0704 | 0.087 |
| 0.1419 | 1.5614 | 0.091 | 0.1078 | 1.1707 | 0.092 | 0.1226 | 1.2153 | 0.101 |
| 0.1672 | 1.8955 | 0.0883 | 0.1226 | 1.5387 | 0.0797 | 0.1561 | 2.1073 | 0.0745 |
| 0.2007 | 2.8321 | 0.0709 | 0.1784 | 2.6983 | 0.0661 | 0.1782 | 2.5756 | 0.0692 |
| 0.2453 | 3.8244 | 0.8641 | 0.2341 | 3.9136 | 0.0598 | 0.2006 | 3.0997 | 0.0647 |
| 0.3456 | 5.5750 | 0.0622 | 0.2787 | 5.3631 | 0.0520 | 0.3285 | 5.7183 | 0.0574 |
| 0.4460 | 7.0802 | 0.0630 | 0.3010 | 5.7534 | 0.0523 | 0.4460 | 6.8684 | 0.0649 |
| 0.5575 | 8.3625 | 0.0667 | 0.4125 | 7.2252 | 0.0571 | 0.4683 | 77.2921 | 0.0642 |

Similar results are also given for 40°.

## Distribution of Iso Valeric Acid at 25° Between Water and:

(Kolossowsky, Kulikow & Bekturow, 1934; 1935.)

| Chloroform | | | Carbon Tetra Chloride | | |
|---|---|---|---|---|---|
| Gm. Mols. iso $C_5H_{10}O_2$ per liter | | $\frac{1}{2}$ | Gm. Mols. iso $C_5H_{10}O_2$ per liter | | $\frac{1}{2}$ |
| $H_2O$ layer(1) | $CHCl_3$ layer(2) | | $H_2O$ layer(1) | $CCl_4$ layer(2) | |
| 0.0023 | 0.0044 | 0.523 | 0.00250 | 0.00122 | 2.05 |
| 0.0039 | 0.0100 | 0.390 | 0.00499 | 0.0038 | 1.30 |
| 0.0059 | 0.0190 | 0.310 | 0.00898 | 0.01104 | 0.813 |
| 0.0120 | 0.060 | 0.200 | 0.0140 | 0.0273 | 0.513 |
| 0.024 | 0.236 | 0.102 | 0.0297 | 0.1076 | 0.276 |
| 0.050 | 0.795 | 0.063 | 0.0529 | 0.340 | 0.156 |
| 0.105 | 2.306 | 0.045 | 0.117 | 1.395 | 0.084 |
| 0.150 | 3.805 | 0.039 | 0.204 | 3.288 | 0.062 |
| 0.202 | 5.040 | 0.041 | 0.347 | 6.399 | 0.054 |
| 0.247 | 5.425 | 0.0455 | 0.412 | 6.946 | 0.059(1) |
| | | | 0.428 | 7.100 | 0.060(1) |

(1) In these cases the aqueous phase is the lower.

## ISO VALERIC ACID

### Distribution of Iso Valeric Acid at 25° Between Water and:

(Kolossowsky, Kulikow & Bekturow, 1934; 1935; Kolossowsky, Bekturow & Kulikow, 1935.)

#### Iso Butyl Alcohol

| Gm. Mols. iso $C_5H_{10}O_2$ per liter | | $\frac{1}{2}$ |
|---|---|---|
| $H_2O$ layer(1) | iso $C_4H_9OH$ layer(2) | |
| 0.0016 | 0.020 | 0.080 |
| 0.0040 | 0.052 | 0.077 |
| 0.0197 | 0.415 | 0.047 |
| 0.0309 | 0.712 | 0.043 |
| 0.0513 | 1.008 | 0.051 |
| 0.1008 | 1.399 | 0.072 |
| 0.166 | 2.130 | 0.078 |
| 0.213 | 3.012 | 0.071 |
| 0.273 | 3.866 | 0.071 |
| 0.308 | 4.554 | 0.068 |
| 0.379 | 6.037 | 0.063 |

#### Iso Amyl Alcohol

| Gm. Mols. iso $C_5H_{10}O_2$ per liter | | $\frac{1}{2}$ |
|---|---|---|
| $H_2O$ layer(1) | iso $C_5H_{11}OH$ layer(2) | |
| 0.0010 | 0.0100 | 0.100 |
| 0.0015 | 0.0260 | 0.057 |
| 0.0032 | 0.0700 | 0.046 |
| 0.0082 | 0.208 | 0.038 |
| 0.020 | 0.530 | 0.038 |
| 0.045 | 1.104 | 0.041 |
| 0.079 | 1.820 | 0.043 |
| 0.125 | 2.611 | 0.048 |
| 0.219 | 4.205 | 0.052 |
| 0.301 | 5.436 | 0.055 |
| 0.039 | 7.320 | 0.060 |

#### Nitro Benzene

| Gm. Mols. iso $C_5H_{10}O_2$ per liter | | $\frac{1}{2}$ |
|---|---|---|
| $H_2O$ layer(1) | $C_6H_5NO_2$ layer(2) | |
| 0.0078 | 0.0109 | 0.716 |
| 0.0156 | 0.0285 | 0.547 |
| 0.0281 | 0.0628 | 0.447 |
| 0.0431 | 0.1260 | 0.342 |
| 0.0929 | 0.3830 | 0.243 |
| 0.183 | 1.466 | 0.125 |
| 0.243 | 2.764 | 0.088 |
| 0.314 | 4.895 | 0.064 |
| 0.398 | 6.921 | 0.057 |
| 0.452 | 7.759 | 0.058 |

#### Xylene

| Gm. Mols. iso $C_5H_{10}O_2$ per liter | | $\frac{1}{2}$ |
|---|---|---|
| $H_2O$ layer(1) | $C_6H_4(CH_3)_2$ layer(2) | |
| 0.0080 | 0.0082 | 0.975 |
| 0.0158 | 0.0263 | 0.600 |
| 0.028 | 0.070 | 0.400 |
| 0.049 | 0.200 | 0.245 |
| 0.094 | 0.693 | 0.137 |
| 0.167 | 2.338 | 0.071 |
| 0.238 | 4.431 | 0.054 |
| 0.332 | 5.775 | 0.057 |
| 0.376 | 6.465 | 0.058 |
| 0.452 | 7.759 | 0.058 |

#### Ethyl Bromide

| Gm. Mols. iso $C_5H_{10}O_2$ per liter | | $\frac{1}{2}$ |
|---|---|---|
| $H_2O$ layer(1) | $C_2H_5Br$ layer(2) | |
| 0.0276 | 0.0540 | 0.51 |
| 0.0351 | 0.1130 | 0.31 |
| 0.0879 | 0.6193 | 0.14 |
| 0.1004 | 1.2738 | 0.079 |
| 0.1242 | 1.8637 | 0.067 |
| 0.1801 | 3.1501 | 0.057 |
| 0.2071 | 3.5140 | 0.059 |
| 0.2887 | 5.7667 | 0.050 |

#### Ortho Nitro Toluene

| Gm. Mols. iso $C_5H_{10}O_2$ per liter | | $\frac{1}{2}$ |
|---|---|---|
| $H_2O$ layer(1) | o $C_6H_4(NO_2)CH_3$ layer(2) | |
| 0.0156 | 0.0225 | 0.693 |
| 0.0241 | 0.0418 | 0.577 |
| 0.0827 | 0.3038 | 0.272 |
| 0.1253 | 0.668 | 0.188 |
| 0.226 | 2.130 | 0.106 |
| 0.316 | 4.545 | 0.0695 |
| 0.413 | 6.621 | 0.0597(1) |
| 0.488 | 8.026 | 0.0608(1) |

(1) In these cases the aqueous layer is the lower.

# ISO VALERIC ACID

## Distribution of Iso Valeric Acid at 25° Between Water and Toluene

(Kolossowski and Ponomarewa, 1934, 1934a.)

| Gm. Equiv. iso $C_5H_{10}O_2$ per liter | | $\frac{1}{2}$ | Gm. Equiv. iso $C_5H_{10}O_2$ per liter | | $\frac{1}{2}$ |
|---|---|---|---|---|---|
| $H_2O$ layer(1) | $C_6H_5CH_3$ layer(2) | | $H_2O$ layer(1) | $C_6H_5CH_3$ layer(2) | |
| 0.0040 | 0.0030 | 1.330 | 0.097 | 0.903 | 0.107 |
| 0.00543 | 0.00458 | 1.186 | 0.124 | 1.376 | 0.090 |
| 0.00825 | 0.01173 | 0.705 | 0.145 | 1.855 | 0.078 |
| 0.01644 | 0.03356 | 0.490 | 0.164 | 2.336 | 0.070 |
| 0.02663 | 0.07337 | 0.363 | 0.183 | 2.817 | 0.065 |
| 0.0481 | 0.2519 | 0.191 | 0.205 | 4.735 | 0.056 |
| 0.0641 | 0.4359 | 0.147 | 0.352 | 6.648 | 0.053 |
| 0.0778 | 0.6222 | 0.125 | 0.493 | 8.507 | 0.058 |

## Distribution of Iso Valeric Acid at Room Temperature Between Water and Petroleum Ether.

(Grossfeld and Miermeister, 1931.)

| cc 0.1 n NaOH per 25 cc | | $\frac{1}{2}$ |
|---|---|---|
| $H_2O$ layer(1) | Pet. Ether layer(2) | |
| 1.00 | 0.14 | 7.14 |
| 5.80 | 4.30 | 1.35 |
| 9.50 | 12.85 | 0.74 |
| 15.00 | 32.10 | 0.47 |
| 20.70 | 60.45 | 0.34 |

## Distribution of Iso Valeric Acid at 25° Between Glycerol and:

(Kolossowski, and Kulikow, 1935a.)

### Chloroform

| Gm. Mol. iso $C_5H_{10}O_2$ per liter | | $\frac{1}{2}$ |
|---|---|---|
| $C_3H_5(OH)_3$ layer(1) | $CHCl_3$ layer(2) | |
| 0.0091 | 0.0206 | 0.442 |
| 0.0171 | 0.0440 | 0.389 |
| 0.0372 | 0.1412 | 0.263 |
| 0.0612 | 0.3178 | 0.193 |
| 0.1201 | 0.8357 | 0.145 |
| 0.2060 | 1.7243 | 0.119 |
| 0.3531 | 3.0249 | 0.117 |
| 0.5061 | 4.1195 | 0.123(1) |
| 0.9063 | 5.5613 | 0.163(1) |

### Nitro Benzene

| Gm. Mol. iso $C_5H_{10}O_2$ per liter | | $\frac{1}{2}$ |
|---|---|---|
| $C_3H_5(OH)_3$ layer(1) | $C_6H_5NO_2$ layer(2) | |
| 0.0153 | 0.0108 | 1.42 |
| 0.0261 | 0.0245 | 1.065 |
| 0.0725 | 0.1036 | 0.702 |
| 0.2014 | 0.4732 | 0.426 |
| 0.3013 | 0.9216 | 0.327 |
| 0.5061 | 2.1010 | 0.241 |
| 0.7533 | 3.8194 | 0.197 |
| 0.8945 | 4.3784 | 0.204 |
| 1.5183 | 5.6908 | 0.267 |

### Toluene

| Gm. Mol. iso $C_5H_{10}O_2$ per liter | | $\frac{1}{2}$ |
|---|---|---|
| $C_3H_5(OH)_3$ layer(1) | $C_6H_5CH_3$ layer(2) | |
| 0.0301 | 0.0398 | 0.756 |
| 0.0424 | 0.1157 | 0.366 |
| 0.0782 | 0.2884 | 0.271 |
| 0.1138 | 0.4849 | 0.235 |
| 0.2119 | 1.2076 | 0.175 |
| 0.3496 | 2.6636 | 0.131 |
| 0.6627 | 5.1317 | 0.129 |
| 0.9569 | 6.4500 | 0.148 |
| 1.3300 | 7.0032 | 0.190 |

(1) The glycerine layer is the lower.

Freezing-point data are given by Timmermans, 1934 for:

Normal valeric acid + Iso valeric acid
" " " + Propionic acid
Iso " " + " "
" " " + Iso Butyric acid

d GLUTAMINE $C_3H_5(NH_2)(CONH_2)COOH$.

SOLUBILITY IN WATER AND IN ETHYL ALCOHOL.
(McMeekin, Cohn and Weare, 1935.)

| Solvent | d. of sat. sol.; | Gm. Mols. $C_5H_{10}O_3N$ per liter |
|---|---|---|
| Water | 1.0124 | 0.291 |
| Ethyl alcohol | 0.7851 | 0.0000315 |

Mono-, Di-, and Tri **ACETIN** $C_3H_5(OH)_2(OC_2H_3O)$, $C_3H_5(OH)(OC_2H_3O)_2$, and $C_3H_5(OC_2H_3O)_3$.
The partition coefficients of these three compounds between olive oil and water are given by Baum (1899) and Meyer (1901, 1909), as 0.06, 0.23, and 0.3 respectively.

BROMO PENTANE $C_5H_{11}Br$.

Freezing-point data for mixtures of 2- Bromo and 3- Bromo Pentane are are given by Lauer and Stodola, 1934.

PIPERIDINE $CH_2<(CH_2.CH_2)_2>NH$.

FREEZING-POINTS OF MIXTURES OF PIPERIDINE AND WATER.
(Ewert, 1937.)

| t° | Mol. Percent $C_5H_{11}N$ in mixture | Solid Phase | t° | Mol. Percent $C_5H_{11}N$ in mixture | Solid Phase |
|---|---|---|---|---|---|
| - 4.6 | 8.4 | Ice | -13.3 | 57.8 | 2 $C_5H_{11}N.H_2O$ |
| -22.8 | 26.9 | " | -12 m.pt.(1) | 66.0 | " |
| -31.9 Eutec. | 33.0 | " + 2 $C_5H_{11}N.H_2O$ | -13.6 | 78.4 | " |
| -27.3 | 35.8 | 2 $C_5H_{11}N.H_2O$ | -16.4 tr.pt. | 82 | " → $C_5H_{11}N$ |
| -19.2 | 47.9 | " | -13.2 | 86.1 | $C_5H_{11}N$ |
| -15.3 | 53.5 | " | -10.0 | 100.0 | " |

(1) with decomposition.

EQUILIBRIUM IN THE SYSTEM PIPERIDINE, ANILINE AND WATER.
(Oustl-Katchkintzev and Mertzline, 1936.)

Results at 0°

| Gms. per 100 gms. homogeneous mixture | | |
|---|---|---|
| $C_5H_{11}N$ | $C_6H_5NH_2$ | $H_2O$ |
| 12.2 | 4.6 | 83.2 |
| 16.5 | 8.7 | 74.8 |
| 22.7 | 18.2 | 59.1 |
| 24.7 | 23.7 | 51.6 |
| 26.4 | 30.2 | 43.4 |
| 26.8 | 36.9 | 36.3 |

Results at 50°

| Gms. per 100 gms. homogeneous mixture | | |
|---|---|---|
| $C_5H_{11}N$ | $C_6H_5NH_2$ | $H_2O$ |
| 8.0 | 4.8 | 87.2 |
| 17.8 | 11.2 | 71.0 |
| 23.5 | 18.0 | 58.5 |
| 25.9 | 23.3 | 50.8 |
| 28.1 | 29.5 | 42.4 |
| 28.8 | 35.8 | 35.4 |
| 16.5 | 68.1 | 15.4 |

The authors also give results for the quarternary systems Piperidine, Pyridine, Aniline and Water at 0°, 20° and 50° and for Piperidine, Pyridine, Acetic Acid and Water at 0°.

## PIPERIDINE

### Equilibrium in the System Piperidine, Phenol and Water.

(Mertzline, 1937.)

| t° of clouding | | Gms. per 100 gms. homogeneous mixture | | | t° of clouding | | Gms. per 100 gms. homogeneous mixture | | |
|---|---|---|---|---|---|---|---|---|---|
| lower | upper | $C_5H_{11}N$ | $H_2O$ | $C_6H_5OH$ | lower | upper | $C_5H_{11}N$ | $H_2O$ | $C_6H_5OH$ |
| — | 135 | 10 | 49.6 | 40.4 | — | 163.5 | 20 | 55 | 25 |
| — | 157 | 10 | 71.3 | 18.7 | — | 159.5 | 30 | 36.6 | 33.4 |
| — | 115.6 | 10 | 35.1 | 54.9 | — | 126.4 | 30 | 19.9 | 50.1 |
| — | 72.8 | 10 | 20.7 | 69.3 | 47.4 | 161.5 | 30 | 50.1 | 19.9 |
| 69 | 124.6 | 10 | 85.4 | 4.6 | 69.4 | 155.4 | 30 | 54.8 | 15.2 |
| 26.4 | 146.8 | 10 | 83.0 | 7.0 | 88.6 | 145.5 | 30 | 58.0 | 12.0 |
| — | 155.0 | 10 | 80.0 | 10.0 | — | 50 | 30 | 9.0 | 61.0 |
| 34.5 | — | 10 | 14.0 | 76.0 | 53.7 | 147.9 | 40 | 30.0 | 30.0 |
| — | 45 | 20 | 11.0 | 69.0 | 92.8 | 142.9 | 40 | 42.0 | 18.0 |
| — | 109.4 | 20 | 20 | 60.0 | 45.6 | 113.8 | 40 | 18.0 | 42.0 |
| — | 146.8 | 20 | 34.8 | 45.2 | 43.2 | 136.3 | 40 | 23.0 | 37.0 |
| 58.5 | 156.6 | 20 | 70.0 | 10.0 | 50.2 | 98.0 | 40 | 16.0 | 44.0 |

The system possesses an upper ternary critical solution point.

### Distribution of Piperidine at 25° Between : (Smith, 1921, 1922.)

#### Water and Chloroform.

| Millimols. $C_5H_{11}N$ per liter | | |
|---|---|---|
| $H_2O$ layer ($C_1$). | $CHCl_3$ layer ($C_2$). | $\frac{C_2}{C_1}$. |
| 0.400 | 0.800 | 2.00 |
| 0.643 | 1.556 | 2.42 |
| 1.200 | 3.625 | 3.02 |
| 1.725 | 6.225 | 3.61 |

#### Water and Ether.

| Millimols. $C_5H_{11}N$ per liter | | |
|---|---|---|
| $H_2O$ layer ($C_1$). | $(C_2H_5)_2O$ layer ($C_2$). | $\frac{C_2}{C_1}$. |
| 1.10 | 1.675 | 0.657 |
| 2.60 | 3.80 | 0.685 |
| 4.85 | 6.70 | 0.724 |
| 8.60 | 11.30 | 0.760 |
| 14.10 | 17.85 | 0.790 |

#### Water and Xylene.

| Millimols. $C_5H_{11}N$ per liter | | |
|---|---|---|
| $H_2O$ layer ($C_1$). | Xylene layer ($C_2$). | $\frac{C_2}{C_1}$. |
| 1.25 | 0.45 | 0.360 |
| 1.85 | 0.75 | 0.406 |
| 2.85 | 1.30 | 0.456 |
| 3.725 | 1.975 | 0.53 |
| 7.00 | 4.00 | 0.57 |

#### Acetone and Glycerol.

| Millimols. $C_5H_{11}N$ per liter | | |
|---|---|---|
| Acetone layer (A). | Glycero layer (G). | $\frac{A}{G}$. |
| 0.225 | 1.3125 | 0.144 |
| 0.725 | 2.85 | 0.254 |
| 0.85 | 3.25 | 0.262 |
| 1.875 | 5.45 | 0.344 |
| 2.375 | 6.775 | 0.350 |

| Millimols. $C_5H_{11}N$ per liter | | |
|---|---|---|
| Acetone layer (A). | Glycerol layer (G). | $\frac{A}{G}$. |
| 4.0 | 9.95 | 0.402 |
| 4.925 | 12.00 | 0.41 |
| 7.8 | 17.35 | 0.45 |
| 10.6 | 23.4 | 0.453 |
| 16.0 | 33.3 | 0.48 |

### Distribution of Piperidine Between Water and Benzene at Ord. Temp.

(Georgievics, 1915.)

| Gms. Piperidine per: | |
|---|---|
| 25 cc. $H_2O$ Layer. | 75 cc. $C_6H_6$ Layer. |
| 0.1573 | 0.4127 |
| 0.256 | 0.674 |
| 0.409 | 1.088 |
| 0.674 | 1.746 |

| Gms. Piperidine per: | |
|---|---|
| 25 cc. $H_2O$ Layer. | 75 cc. $C_6H_6$ Layer. |
| 0.891 | 2.339 |
| 1.299 | 3.589 |
| 1.712 | 4.789 |

Freezing-point data are given for the following mixtures.

Piperidine + Acetic Acid (Puschin and Rikovsky, 1932a.)
" + o Cresol (Puschin and Sladovic, 1928.)
" + Guaicol (Puschin and Rikovski, 1937.)
" + Cyclohexane (Mascarelli and Constantino, 1909, 1910.)

**PIPERIDINE HYDROCHLORIDE** $CH_2<(CH_2.CH_2)_2>NH.HCl$.

SOLUBILITY IN SEVERAL SOLVENTS. (Freundlich and Richards, 1912.)

| Solvent. | t°. | Mols. Piperidine HCl per Liter. |
|---|---|---|
| Water | 0 | 4.87 |
| " | 25 | 5.19 |
| Tetrachlor Ethane (sat. with $H_2O$) | 0 | 0.13 |
| " " " | 25 | 0.29 |
| Nitrobenzene " | 25 | 0.00543 |
| Benzene " | 25 | 0.00102 |

Methyl**PIPERIDINES** 2-, 3-, 4-, *n* Methyl, etc.

Data for the reciprocal solubility of 2-methylpiperidine and water, 3-methylpiperidine and water, 4-methylpiperidine and water, nitrosopiperidine and water and for *n*-methylpiperidine and water, determined by the synthetic (sealed tube) method of Alexejeff, are given by Flaschner and MacEwan (1908) and by Flaschner (1909) and (1908). Similar data for *n*-ethylpiperidine and water and for *n*-propylpiperidine and water are given by Flaschner (1908).

**VALERAMIDES**

DISTRIBUTION OF VALERAMIDES BETWEEN WATER AND OLIVE OIL AT 15°.
(Harrass, 1903.)

| Amide. | Formula. | Gms. Cmpd. per per 100 cc. Water Layer. | Gms. Cmpd. per per 100 cc. Olive Oil Layer. | Ratio $\frac{Conc._{oil}}{Conc._{H_2O}}$. |
|---|---|---|---|---|
| Valeramide | $CH_3(CH_2)_3CONH_2$ | 0.769 | 0.241 | 0.313 |
| Valerethylamide | $CH_3(CH_2)_3CONH(C_2H_5)$ | 1.029 | 0.261 | 0.254 |
| Valerdiethylamide | $CH_3(CH_2)_3CON(C_2H_5)_2$ | 0.231 | 1.339 | 5.797 |
| Valerdimethylamide | $CH_3(CH_2)_3CON(CH_3)_2$ | 0.011 | 0.379 | 0.416 |
| Lactdiethylamide | $CH_3CHOHCON(C_2H_5)_2$ | 1.256 | 0.194 | 0.154 |

**α AMINO VALERIC ACID** $CH_3CH_2CH_2CH(NH_2)COOH$.

DISTRIBUTION OF α AMINO VALERIC ACID BETWEEN WATER AND NORMAL BUTYRIC ACID AT 25°.
(England, Albert, and Cohn, 1936.)

| Gm. Mols. $C_5H_{11}O_2N$ per liter | | $\frac{2}{1}$ |
|---|---|---|
| $H_2O$ layer(1) | Butyl alcohol layer(2) | |
| 0.022 | 0.0023 | 0.105 |
| 0.128 | 0.0153 | 0.120 |
| 0.270 | 0.302 | 0.112 |

**BETAINE** (Trimethyl glycocoll) $C_5H_{11}O_2N.H_2O$.

SOLUBILITY OF ANHYDROUS BETAINE IN WATER AND ALCOHOLS.
(Stoltzenberg, 1914.)
(Figures read from the author's curves.)

| t°. | Gms. $C_5H_{11}O_2N$ per 100 Gms. $H_2O$. | $CH_3OH$. | $C_2H_5OH$. | t°. | Gms. $C_5H_{11}O_2N$ per 100 Gms. $H_2O$. | $CH_3OH$. | $C_2H_5OH$. |
|---|---|---|---|---|---|---|---|
| −10 | 134 | 38 | 5 | 50 | 197 | 70 | 16 |
| 0 | 140 | 43 | 6 | 60 | 215 | 75 | 18.5 |
| +10 | 147 | 49 | 7 | 70 | 236 | 80 | 22 |
| 20 | 157 | 54 | 8.5 | 80 | 259 | .. | 25 |
| 30 | 168 | 60 | 11 | 90 | 286 | .. | ... |
| 40 | 182 | 65 | 13 | 100 | 328 | .. | ... |

## BETAINE SALTS.

### Solubility of Each, Separately, in Water.

(Stoltzenberg, 1914.)

Grams per 100 Grams $H_2O$.

| t°. | $C_5H_{11}O_2N$. HCl. | $C_5H_{11}O_2N$. HBr. | $C_5H_{11}O_2N$. HI. | $C_5H_{11}O_2N$. $H_2SO_4.H_2O$. | $C_5H_{11}O_2N$. $H_3PO_4$. | $C_5H_{11}O_2N$. $HMnO_4$. | $C_5H_{11}O_2N$. $HAuCl_4$. |
|---|---|---|---|---|---|---|---|
| −10 | 38 | 28 | 35 | 67 | 35 | 1.5 | 1.3 |
| 0 | 44 | 39 | 66 | 86 | 45 | 1.75 | 1.5 |
| +10 | 52 | 52 | 98 | 107 | 58 | 2.5 | 2 |
| 20 | 60 | 65 | 130 | 132 | 73 | 5 | 3 |
| 30 | 70 | 79 | 162 | 164 | 91 | 9 | 4.5 |
| 40 | 81 | 94 | 198 | 203 | 112 | 16 | 6 |
| 50 | 93 | 110 | 231 | 250 | 135 | 30 | 8 |
| 60 | 106 | 127 | 269 | 306 | 160 | (55°) 48 | 11.5 |
| 70 | 120 | 144 | 304 | ... | 190 | ... | 15 |
| 80 | 135 | 162 | (75°) 321 | ... | 223 | ... | 18 |
| 90 | 151 | 183 | ... | ... | ... | ... | 23 |
| 100 | 169 | 206 | ... | ... | ... | ... | ... |

Data are also given by Stoltzenberg for the following basic salts of betaine $(C_5H_{11}O_2N)_2HCl.H_2O$, $(C_5H_{11}O_2N)_2.HBr$, $(C_5H_{11}O_2N)_2HI$, $(C_5H_{11}O_2N)_2H_2SO_4$ and $(C_5H_{11}O_2N)_2HAuCl_4.H_2O$.

## dl VALINE $(CH_3)_2CHCH(NH_2)COOH$.

### Solubility of dl Valine in Water.

(Dalton and Schmidt, 1933.)

The following values were derived from a solubility equation based upon 52 very careful determinations made at 15 temperatures between 0° and 80°. Density determinations upon dilute aqueous valine solutions are also given. The $d_{25}$ of a 7.4 percent solution is 1.01387.

| t° | Gms. $C_5H_{11}O_2N$ per 100 gms. $H_2O$ | t° | Gms. $C_5H_{11}O_2N$ per 100 gms. $H_2O$ | t° | Gms. $C_5H_{11}O_2N$ per 100 gms. $H_2O$ |
|---|---|---|---|---|---|
| 0 | 5.96(7.011) | 30 | 7.42 | 60 | 10.28 |
| 5 | 6.13 | 35 | 7.77 | 65 | 10.97 |
| 10 | 6.33 | 40 | 8.17 | 70 | 11.74 |
| 15 | 6.56 | 45 | 8.61 | 75 | 12.61(13.31) |
| 20 | 6.81 | 50 | 9.11(9.424) | 100 | 18.81(20.0) |
| 25 | 7.09(7.441) | 55 | 9.67 | | |

The results in parentheses are by Dunn, Ross and Read, 1933.

### Solubility of dl Valine in Aqueous Solutions of Ethyl Alcohol.

(Dunn and Ross, 1938.)

| t° | Wt. % $C_2H_5OH$ in aq. solvent | d. of sat. sol. | Gms. $C_5H_{11}O_2N$ per 100 gms. solvent | t° | Wt. % $C_2H_5OH$ in aq. solvent | d. of sat. sol. | Gms. $C_5H_{11}O_2N$ per 100 gms. solvent |
|---|---|---|---|---|---|---|---|
| 0 | 20.32 | 0.975 | 2.10 | 45 | 20.00 | 0.966 | 5.10 |
| " | 42.52 | 0.942 | 0.769 | " | 42.66 | 0.918 | 2.74 |
| " | 66.94 | 0.881 | 0.269 | " | 67.11 | 0.857 | 0.999 |
| " | 92.61 | 0.819 | 0.0277 | " | 92.61 | 0.795 | 0.0979 |
| " | 100.0 | 0.797 | 0.0136 | 65 | 20.0 | 0.962 | 7.44 |
| 25 | 20.62 | 0.971 | 3.30 | " | 42.52 | 0.905 | 4.49 |
| " | 43.36 | 0.924 | 1.53 | " | 66.94 | 0.841 | 1.62 |
| " | 67.11 | 0.870 | 0.57 | " | 92.54 | 0.782 | 0.167 |
| " | 92.61 | 0.807 | 0.0569 | | | | |

### Solubility of dl Valine and of d Valine, Each Separately, in Aqueous Solutions of Ethyl Alcohol at 25°.

(Cohn, McMeekin, Edsall and Weare, 1934.)

Results for dl Valine

| Vol. % $C_2H_5OH$ in aq. solvent | d. of sat. sol. | Gm. Mol. $C_5H_{11}O_2N$ per liter sat. sol. |
|---|---|---|
| 0.0 = $H_2O$ | 1.0120 | 0.571 (= 66.9 gm.) |
| 20.0 | 0.9814 | 0.318 |
| 40.0 | 0.9512 | 0.167 |
| 60.0 | 0.9092 | 0.086 |
| 80 | 0.8575 | 0.028 |
| 90 | 0.8256 | 0.00922 |
| 100 | 0.7851 | 0.00128 |

Results for d Valine

| Vol. % $C_2H_5OH$ in aq. solvent | d. of sat. sol. | Gm. Mol. $C_5H_{11}O_2N$ per liter sat. sol. |
|---|---|---|
| 0.0 = $H_2O$ | 1.0148 | 0.7061 (= 82.63 gm.) |
| 20.0 | 0.9853 | 0.409 |
| 20.0 | 0.9528 | 0.231 |
| 60.0 | 0.9100 | 0.123 |
| 80 | 0.8565 | 0.0373 |

### Distribution of Valine Between Water and Normal Butyl Alcohol at 25°.

(England, Albert and Cohn, 1934.)

| Gm. Mols. $C_5H_{11}O_2N$ per liter | | $\frac{2}{1}$ |
|---|---|---|
| $H_2O$ layer(1) | Butyl alc. layer(2) | |
| 0.054 | 0.0038 | 0.0722 |
| 0.268 | 0.0193 | 0.0722 |
| 0.271 | 0.0206 | 0.0762 |

100 cc Butyric Acid dissolve 0.056 gm. Valine at 18°.
(v. Przylecki and Kasprzyk-Czaykowska, 1938.)

**METHIONINE** dl $CH_3SCH_2CH_2CH(NH_2)COOH$.

### Solubility of Methionine in Water.

(Dalton and Schmidt, 1935.)

The following results were calculated from a solubility equation based upon 36 very careful determinations made at 9 temperatures between 0° and 62°. The densities of several solutions are given. The density of a 3.337 percent solution at 25° is 1.00678.

| t° | Gms. $C_5H_{11}O_2NS$ per 100 gms. $H_2O$ | t° | Gms. $C_5H_{11}O_2NS$ per 100 gms. $H_2O$ | t° | Gms. $C_5H_{11}O_2NS$ per 100 gms. $H_2O$ |
|---|---|---|---|---|---|
| 0 | 1.818 | 30 | 3.812 | 60 | 7.545 |
| 5 | 2.064 | 35 | 4.290 | 65 | 8.478 |
| 10 | 2.340 | 40 | 4.824 | 70 | 9.452 |
| 15 | 2.650 | 45 | 5.415 | 75 | 10.52 |
| 20 | 2.995 | 50 | 6.070 | 100 | 17.60 |
| 25 | 3.381 | 55 | 6.795 | | |

100 cc Acetic Acid dissolve 1.75 gms. Methionine at 18°.
(V. Przylechi and Kasprzyk-Czaykowska, 1938.)

**ETHYL URETHAN** $C_2H_5NH.COOC_2H_5$.

100 gms. $H_2O$ dissolve 72.31 gms. $C_5H_{11}O_2N$ at 15.5°. (Führer, 1924.)

**PENTANE** $CH_3(CH_2)_3CH_3$.

100 cc. sat. sol. of pentane in water contain 0.06 cc. $CH_3(CH_2)_3CH_3$ at 16°
(Führer, 1924.)

Data for the solubility of pentane in liquid carbon dioxide, determined by the synthetic method, are given by Büchner (1906).

Iso**PENTANE** $(CH_3)_2CH.CH_2CH_3$.

RECIPROCAL SOLUBILITY OF ISOPENTANE AND PHENOL. (Campetti and Del Grosso, 1913.)

| t°. | Gms. Phenol per 100 Gms. Isopentane Rich Layer. | Phenol Rich Layer. |
|---|---|---|
| 20 | 4·5 | 87 |
| 30 | 7 | 83·5 |
| 40 | 11·5 | 80 |
| 50 | 18 | 75·5 |
| 60 | 29·5 | 68 |
| 65 | 40 | 58 |
| 66 crit. temp. | 50 | |

F.-pt. data for mixtures of hexachloro-α-keto γ-*R*-pentene, $C_5Cl_6O$, + penta chloromonobromo α-keto γ-*R* pentene, $C_5Cl_5BrO$, are given by Küster (1890, 1891).

The critical solution temperature of mixtures of pentane and Sulfur Dioxide is at 2.0° and there is approximately 75 Mol. percent $SO_2$ present, (Leslie, 1934.)

The critical solution temperature of mixtures of iso pentane and o nitro toluene is 8.65°. That of mixtures of iso pentane and m nitro toluene is 7.05°. (Hennant-Roland, 1933.)

## HYDROCARBONS.

In connection with the use of liquid sulfur dioxide for the fractionation of mixtures of hydrocarbons, many determinations have been made of the solubility of aromatics, paraffines, olefins and naphthenes in this solvent. A general review of the subject and many new experiments are given by Moore, Morrell and Egloff, 1918. The methods are, however, more in the nature of fractional extraction processes than equilibria studies. Mixtures of various proportions of liquid sulfur dioxide and oil were shaken together, usually at — 18° or — 10°, and, after separation of the two layers, each was freed of $SO_2$ and its density and refractive index determined. It was found in general that the paraffines (pentane, hexane, octane, nonane and decane) are completely insoluble and the aromatics and olefins (benzene, toluene, xylene, mesitylene, hexylene, and caprylene) completely soluble in liquid sulfur dioxide. Naphthalene and cyclohexane varied in solubility depending upon the ratio of $SO_2$ used. Data for a great variety of synthetic mixtures of hydrocarbons are given and it was found that within certain limiting concentrations : (a) Aromatics may be separated from paraffins or naphthenes, (b) Olefins may be separated from paraffins or naphthenes, (c) Aromatics and olefins together may be separated from paraffins or naphthenes, (d) Naphthenes may be separated from paraffins. The particular advantage of the method is that the separated unsaturated and aromatic oils may be recovered and their identity proven by further physical tests.

Freezing-point data are given for mixtures of:

| | | |
|---|---|---|
| Pentane | + Iso pentane | (Ormandy & Craven, 1921; Saphir, 1929.) |
| " | + Methyl cyclohexane | (Timmermans, 1934.) |
| Iso pentane | + $CS_2$ | (Saphir, 1929.) |
| " | + Acetone | " " |
| " | + Ethyl Ether | " " |
| " | + Ethyl bromide | " " |
| " | + Hexane | (Timmermans, 1934.) |
| " | + Nitro benzene | ( " 1910, 1911.) |

**AMYL ALCOHOL** $C_5H_{11}OH$.

SOLUBILITY OF AMYL ALCOHOL IN WATER AT 22°.
(Herz — Ber. 31, 2671, '98.)

100 cc. water dissolve 3.284 cc. amyl alcohol. Sp. Gr. of solution = 0.9949, Volume = 102.99 cc.
100 cc. amyl alcohol dissolve 2.214 cc. water. Sp. Gr. of solution = 0.8248, Volume = 101.28 cc.
Sp. Gr. of $H_2O$ at 22° = 0.9980; Sp. Gr. of amyl alcohol at 22° = 0.8133.

100 gms. sat. solution of normal amyl alcohol in water contain 2.208 gm. $C_5H_{11}OH$ at 25°. (Butler, Thomson and Maclennen, 1933.)
100 gms. $H_2O$ dissolve 5.2 gm. Amyl Alcohol at 20°. (Smith, 1932.)

SOLUBILITY OF AMYL ALCOHOL IN WATER AND IN AQUEOUS SOLUTIONS OF ETHYL AND METHYL ALCOHOLS.
(Fontein, 1910.)

| In Water. | | | In Aq. Ethyl Alcohol.* | | | In Aq. Methyl Alcohol.† | | |
|---|---|---|---|---|---|---|---|---|
| t°. | Gms. $C_5H_{11}OH$ per 100 Gms. | | t°. | Gms. $C_5H_{11}OH$ per 100 Gms. | | t°. | Gms. $C_5H_{11}OH$ per 100 Gms. | |
| | $H_2O$ Layer. | $C_5H_{11}OH$ Layer. | | $C_2H_5OH+H_2O$ Layer. | $C_5H_{11}OH$ Layer. | | $CH_3OH+H_2O$ Layer. | $C_5H_{11}OH$ Layer. |
| 0.5 | 4 | ... | 4.5 | 16.2 | ... | 3.6 | 11 | ... |
| 15.5 | 2.6 | 90.7 | 20 | 20.8 | ... | 20 | 19.3 | ... |
| 20 | 2.6 | 90.6 | 40 | 26.7 | ... | 38.4 | ... | 78.4 |
| 40 | 2.1 | 89.5 | 60 | 33 | ... | 40 | 31.2 | 78 |
| 60 | 2 | 88 | 67.8 | ... | 24.4 | 50 | 37.1 | 74.8 |
| 80 | 2.5 | 86 | 70 | 36.5 | 73.7 | 60 | 43.3 | 71.6 |
| 100 | 3 | 83.8 | 80 | 40.8 | 70.1 | 70 | 52.7 | 65 |
| 120 | 3.8 | 80.8 | 90 | 47 | 64 | 72 | (crit. temp.) | |
| 140 | 5 | 76.4 | 94.2 | (crit. temp.) | | | | |
| 160 | 7.3 | 70 | | | | | | |
| 170 | 9.3 | 65.1 | | | | | | |
| 180 | 13.5 | 57.3 | | | | | | |
| 187.5 | (crit. temp.) | | | | | | | |

* Of 33.55 per cent $C_2H_5OH$. † Of 33 per cent $CH_3OH$.

The "synthetic method" was used for the preceding determinations. Fermentation amyl alcohol of b. pt. 131°–131.4° and $d_{15.5} = 0.814$ was employed. It contained 16% of optically active amyl alcohol. Many other series of determinations were made with solvents containing other percentages of ethyl and methyl alcohol. Also, other series were made for the above-named ternary systems at constant temperatures from which binodal curves were obtained. The author uses a very ingenious indirect method for determining the composition of the conjugated solutions. Data are also given for the distribution of ethyl alcohol between water and amyl alcohol.

The results of Alexejew (1886) for the solubility of amyl alcohol in water agree fairly well with the above data.

### Solubility of Amyl Alcohol in Aqueous Solutions of Ethyl Alcohol.

(Pfeiffer, 1892; Bancroft, 1895-96.)

| Mixture of $C_5H_{11}OH + C_2H_5OH$ | | c.c. $H_2O$ added to * Mixture at | | Mixture of $C_5H_{11}OH + C_2H_5OH$ | | c.c. $H_2O$ Added to * Mixture at | |
|---|---|---|---|---|---|---|---|
| c.c. | c.c. | 9.1° | 19.2°. | c.c. | c.c. | 13.3°. | 17 4°. |
| 3 | 3 | 3.21 | 3.5 | 3 | 3 | 3.36 | 3.47 |
| 3 | 6 | 10.35 | 10.80 | 6 | 3 | 2.20 | 2.25 |
| 3 | 9 | 18.34 | 19.10 | 9 | 3 | 2.10 | 2.15 |
| 3 | 12 | 27.47 | 29.15 | 12 | 3 | 2.10 | 2.10 |
| 3 | 15 | 41.25 | 43.15 | 15 | 3 | 2.10 | 2.10 |

* Just enough water was added to produce cloudiness.

Note. — The effect of various amounts of a large number of salts upon the temperature (39.8°) at which a mixture of 20 cc. of amyl alcohol + 20 cc. of ethyl alcohol + 32.9 cc. of water becomes homogeneous has been investigated by Pfeiffer (Z. phys. Ch. 9, 444, '92). The results are no doubt of interest from a solubility standpoint, but their recalculation to terms suitable for presentation in the present compilation has not been attempted.

## IsoAMYL ALCOHOL $(CH_3)_2CH.(CH_2)_2OH$.

### Reciprocal Solubility of Isoamyl Alcohol and Water.

(Kablukov and Malischeva, 1925.)

A volumetric method, apparently identical with that described by Hill, 1923, was used. The method of calculation eliminates the correction for change of volume on mixing and permits direct estimation from the volumetric results.

Solubility of Isoamyl Alcohol in Water.

| t°. | d of $H_2O$ layer. | Gms. Alcohol per 100 gms. $H_2O$ layer. K and M. | Fontein, 1923. |
|---|---|---|---|
| 15.. | 0.9929 | 3.04 | 2.72 |
| 20.. | 0.9924 | 2.82 | – |
| 25.. | 0.9914 | 2.67 | – |
| 30.. | 0.9904 | 2.56 | 2.31 (29°) |

Solubility of Water in Isoamyl Alcohol.

| t°. | d of Alcohol layer. | Gms. $H_2O$ per 100 gms. Alcohol layer. K and M. | Fontein, 1923. |
|---|---|---|---|
| 15.. | 0.8306 | 9.33 | 9.31 (15° 5) |
| 20.. | 0.8275 | 9.60 | – |
| 25.. | 0.8242 | 9.87 | – |
| 30.. | 0.8209 | 10.15 | 10.18 (34°). |

The determinations quoted from Fontein were made by the « turbidity point » method. A small scale diagram, without numerical results, is given for the above system by Brun, 1925.

### Solubilities of Isoamyl Compounds in Water. (Fühner, 1924.)

| Compound. | Formula. | d of cmpd. | t°. | Gms. Cmpd. per 100 gms. sat. sol. |
|---|---|---|---|---|
| Isoamyl alcohol..... | $(CH_3)_2CH.(CH_2)_2OH$ | 0.81 | 18 | 2.75 |
| Isoamyl bromide.... | $(CH_3)_2CH.(CH_2)_2Br$ | 1.17 | 16.5 | 0.02 |
| Isoamyl urethan..... | | – | 15.5 | 0.48 |

### Mutual Solubility of Isoamyl Alcohol and Glycerol. (Mc Ewen, 1923.)

| t°. | Gms. Alcohol per 100 gms. sat. sol. | t°. | Gms. Alcohol per 100 gms. sat. sol. | t°. | Gms. Alcohol per 100 gms. sat. sol. |
|---|---|---|---|---|---|
| 21.5..... | 5.05 | 73.7..... | 27.62 | 54.41..... | 69.3 |
| 58.0..... | 10.35 | 74.2*.... | 31.90 | 61.4..... | 62.4 |
| 66.5..... | 13.97 | 74.1*.... | 36.79 | 36.8..... | 76.21 |
| 71.5..... | 19.20 | 73.0..... | 46.16 | 12.5..... | 84.26 |

* Temperature of critical opalescence.

### Solubility of Iso Amyl Alcohol in Aqueous Solutions of Several Sodium Salts of Organic Acids at About 18°.

(Traube, Schöning and Weber, 1927.)

| Composition of aqueous solvent | cc $\frac{1}{5}$ $C_5H_{11}OH$ per 5 cc aq. solvent | Composition of aqueous solvent | cc $\frac{1}{5}$ $C_5H_{11}OH$ per 5 cc aq. solvent |
|---|---|---|---|
| Water alone | 0.15 | 1.75n Na Salicylate | 17.4 |
| 0.5 n Na benzoate | 0.12 | 2.00 " " " | ∞ |
| 1.0 " " " | 0.10 | Sat. Na naphthionate | 0.15 |
| 1.25" " " | 0.17 | 1.0 n Na p oxybenzoate | 0.15 |
| 1.5 " " " | 0.63 | 2.0 " " " | 0.45 |
| 1.75" " " | 2.85 | 2.0 " Na butyrate | 0.075 |
| 1.875 " " | 5.00 | ¼ sat. " " | 0.08 |
| 2.0 " " " | ∞ | ½ " " " | 1.6 |
| 0.5 " " benzene sulfonate | 0.15 | 2/3" " " | ∞ |
| 1.0 " " " " | 0.15 | 2.0 n Na tartrate | 0.05 |
| 1.5 " " " " | 0.2 | sat. " " | 0.02 |
| 2.0 " " " " | 0.525 | 1.0 n Na succinate | 0.12 |
| sat. " " " | 0.9 | 2.0 n Na citrate | 0.07 |
| 1.0 " " hippurate | 0.2 | sat. " " | 0.03 |
| 1.5 " " " | 0.05 | 2.0 n " acetate | 0.07 |
| 1.75" " " | 3.0 | ¼ sat. aniline hydrochloride | 0.1 |
| 2.0 " " " | ∞ | ½ " " " | 0.25 |
| 0.5 " " salicylate | 0.6 | sat. " " | ∞ |
| 1.0 " " " | 1.2 | sat. ammonium nitrate | 0.1 |
| 1.25" " " | 2.5 | " casium nitrate | 0.1(1) |
| 1.50" " " | 5.6 | | |

(1) Normal amyl alcohol.

Results are also given for the increase in solubility of iso amyl alcohol by sodium cinnamate and vice versa at 25°.

100 gms. aqueous 0.2 normal sodium oleate solution dissolve 58 gms. $C_5H_{11}OH$ at 20°. (Smith, 1932.)

### Distribution of Isoamyl Alcohol between Water and Cotton Seed Oil at 25°.

(Wroth and Reid, 1916.)

| Gms. $C_5H_{11}OH$ per 100 c.c. | | |
|---|---|---|
| Oil Layer. | $H_2O$ Layer. | Ratio. |
| 1.947 | 0.9153 | 0.470 |
| 2.195 | 1.1156 | 0.508 |
| 2.273 | 1.1050 | 0.486 |
| 2.372 | 0.9995 | 0.421 |

**AMYLENE HYDRATE** $(CH_3)_2C(OH)CH_2.CH_3$.

The distribution coefficient of amylene hydrate between olive oil and water at ord. temp. is 1.

(Baum, 1899.)

## Reciprocal Solubility of Eight Isomeric Carbinols and Water, Each Determined Seperately.

(Ginnings and Baum, 1937.)

| Isomeric $C_5H_{12}O$ Carbinol | Formula | t° | Gms. Carbinol per 100 gms. $H_2O$ phase | Gms. Carbinol per 100 gms. Carbinol phase |
|---|---|---|---|---|
| n Butyl (= 1 Pentanol) | $CH_3(CH_2)_3CH_2OH$ | 20 | 2.36(0.8317) | 92.52(0.9939) |
| " | " | 25 | 2.19(0.8287) | 92.54(0.9930) |
| " | " | 30 | 2.03(0.8253) | 92.35(0.9919) |
| iso Butyl (= iso amyl alcohol) | $(CH_3)_2CHCH_2CH_2OH$ | 20 | 2.85(0.8286) | 90.53(0.9941) |
| " | " | 25 | 2.67(0.8257) | 90.39(0.9932) |
| " | " | 30 | 2.53(0.8188) | 90.24(0.9921) |
| sec Butyl (= 1 Butanol 2-Methyl) | $CH_3CH_2CH(CH_3)CH_2OH$ | 20 | 3.18 (0.8311) | 91.05(0.9943) |
| " | " | 25 | 2.97 (0.8288) | 90.81(0.9930) |
| " | " | 30 | 2.83 (0.8239) | 90.74(0.9928) |
| ter Butyl (= 1 Propanol 2.2 dimethyl) | $(CH_3)_3CCH_2OH$ | 20 | 3.74(0.8243) | 91.77(0.9936) |
| " | " | 25 | 3.50(0.8216) | 91.64(0.9930) |
| " | " | 30 | 3.28(0.8178) | 91.46(0.9925) |
| Methyl n Propyl (= 2 Pentanol) | $CH_3CH_2CH_2CHOHCH_3$ | 20 | 4.86(0.8317) | 88.30(0.9914) |
| " | " | 25 | 4.46(0.8280) | 88.21(0.9909) |
| " | " | 30 | 4.13(0.8243) | 88.10(0.9898) |
| Di ethyl (= 3 Pentanol) | $CH_3CH_2CHOHCH_2CH_3$ | 20 | 5.61(0.8368) | 91.81(0.9920) |
| " | " | 25 | 5.15(0.8330) | 91.68(0.9914) |
| " | " | 30 | 4.75(0.8294) | 91.42(0.9903) |
| Methyl iso propyl (= 2 Butanol 3-methyl) | $(CH_3)_2CHCHOHCH_3$ | 20 | 6.07(0.8390) | 88.12(0.9909) |
| " | " | 25 | 5.55(0.8352) | 88.07(0.9902) |
| " | " | 30 | 5.10(0.8348) | 87.95(0.9879) |
| Dimethyl ethyl (= 2 Butanol 2 methyl | $CH_3CH_2C(CH_3)OHCH_3$ | 20 | 12.15(0.8662) | 75.74(0.9837) |
| " | " | 25 | 11.00(0.8552) | 76.53(0.9829) |
| " | " | 30 | 10.10(0.8498) | 77.31(0.9828) |

The figures in parentheses are the densities of the respective phases at 25/4°.

$C_5H_{12}O_1$

## Reciprocal Solubility of Six Isomeric Ethers and Water, Each Determined Separately.

(Bennett and Philip, 1928.)

The method of Hill, 1923, was modified by greatly reducing the volumes of liquid and adding a globule of mercury to the small sealed tube to hasten the mixing and attainment of equilibrium.

| Isomeric $C_5H_{12}O$ Ether | A = Wt. % of Ether in Aqueous Phase<br>B = Wt. % of $H_2O$ in Ether Phase at: | 0° | 10° | 15° | 20° | 25° |
|---|---|---|---|---|---|---|
| Methyl n-Butyl | A | 2.51 | 1.51 | 1.18 | 1.00 | 0.89 |
| | B | 0.50 | 0.45 | 0.57 | 0.71 | 0.91 |
| Methyl iso-Butyl | A | 2.53 | 1.79 | 1.51 | 1.24 | 1.10 |
| | B | 0.92 | 1.30 | 1.54 | 1.78 | 2.02 |
| Methyl sec.-Butyl | A | 3.24 | 2.33 | 2.05 | 1.79 | 1.60 |
| | B | 0.80 | 1.22 | 1.48 | 1.69 | 1.95 |
| Methyl tert.-Butyl | A | 9.12 | 7.30 | 6.55 | 5.83 | 5.16 |
| | B | 1.17 | 1.84 | 2.20 | 2.54 | 2.95 |
| Ethyl n-Propyl | A | 3.66 | 2.24 | 2.32 | 2.03 | 1.87 |
| | B | 0.69 | 0.76 | 0.88 | 1.01 | 1.13 |
| Ethyl iso Propyl | A | 5.89 | 3.99 | 3.35 | 2.82 | 2.40 |
| | B | 0.26 | 0.22 | 0.30 | 0.41 | 0.52 |

**ETHYLAL** (Diethoxy Methane) $CH_2(OC_2H_5)_2$.

Freezing-point data are given for mixtures of:

Ethylal and Methylal (Saphir, 1929.)
" " Ethyl Ether (Timmermans, 1934.)

**DIMETHYL SULFON DIMETHYL METHANE** etc.

### Distribution between Water and Olive Oil at Room Temp.

(Baum, 1899; Meyer, 1909.)

| Compound. | Formula. | Gms. Cmpd. per 100 cc. $H_2O$ Layer (*w*). | Gms. Cmpd. per 100 cc. Oil Layer (*o*). | Ratio $\frac{(o)}{(w)}$. |
|---|---|---|---|---|
| Dimethyl Sulfon Dimethyl Methane | $(CH_3)_2C(SO_2.CH_3)_2$ | 0.6072 | 0.0622 | 0.103 |
| Diethyl Sulfon Methane | $CH_2(SO_2C_2H_5)_2$ | 0.610 | 0.092 | 0.151 |
| Sulfonal | $(CH_3)_2C(SO_2C_2H_5)_2$ | 0.070 | 0.0686 | 0.979 |
| Trional | $(CH_3)(C_2H_5)C(SO_2.C_2H_5)_2$ | 0.0404 | 0.1646 | 4.074 |
| Tetronal | $(C_2H_5)_2C(SO_2.C_2H_5)_2$ | 0.0462 | 0.1446 | 3.756 |

**AMYL AMINE** $C_5H_{11}.NH_2$.

The freezing-point curve for mixtures of amyl amine and water is given by Pickering (1893).

**AMYL AMINES** $n\,CH_3(CH_2)_4.NH_2$ and Iso $(CH_3)_2CH.CH_2CH_2NH_2$.

### Distribution of Each between Water and Xylene at 25°. (Smith, 1921-1922.)

Results for *n* Amylamine.

| Millimols. $CH_3(CH_2)_4.NH_2$ per liter of $H_2O$ layer ($C_1$). | Millimols. $CH_3(CH_2)_4.NH_2$ per liter of Xylene layer ($C_2$). | $\frac{C_2}{C_1}$. |
|---|---|---|
| 0.755 | 1.15 | 1.52 |
| 1.335 | 2.67 | 2.00 |
| 1.875 | 4.275 | 2.28 |
| 2.655 | 7.17 | 2.70 |
| 5.08 | 14.92 | 2.94 |

Results for Isoamylamine.

| Millimols. $(CH_3)_2CH.(CH_2)_2NH_2$ per liter of $H_2O$ layer ($C_1$). | Millimols. $(CH_3)_2CH.(CH_2)_2NH_2$ per liter of Xylene. layer ($C_2$). | $\frac{C_2}{C_1}$. |
|---|---|---|
| 0.525 | 0.650 | 1.24 |
| 0.55 | 0.700 | 1.28 |
| 0.75 | 1.073 | 1.43 |
| 1.00 | 1.50 | 1.50 |
| 2.65 | 5.10 | 1.92 |

DISTRIBUTION OF : (Smith, 1921-1922.)

*n* Amyl Amine between Water and Chloroform at 25°.

| Millimols. $CH_3(CH_2)_4.NH_2$ per liter of | | |
|---|---|---|
| Water layer ($C_1$). | $CHCl_3$ layer ($C_2$). | $\frac{C_2}{C_1}$. |
| 0.1168 | 0.6832 | 5.86 |
| 0.150 | 1.20 | 8.0 |
| 0.1735 | 1.70 | 9.8 |
| 0.200 | 2.30 | 11.5 |

Isoamyl Amine between Water and Ether at 25°.

| Millimols. $(CH_3)_2CH(CH_2)_2.NH_2$ per liter of | | |
|---|---|---|
| $H_2O$ layer ($C_1$). | Ether layer ($C_2$). | $\frac{C_2}{C_1}$. |
| 0.2375 | 0.3875 | 1.63 |
| 0.3750 | 0.6500 | 1.73 |
| 0.4875 | 1.0125 | 2.08 |
| 0.8375 | 1.8375 | 2.19 |

DISTRIBUTION OF DIISO AMYL AMINE ACID PHTHALATE BETWEEN ACETONE AND GLYCEROL AT 25°.
(Smith, 1921-1922.) (See Note. p. 213.)

| Millimols. Di isoamylamine Acid Phthalate per liter of | | |
|---|---|---|
| Glycerol layer (G). | Acetone layer (A). | $\frac{(A)}{(G)}$. |
| 1.9375 | 1.750 | 0.905 |
| 3.075 | 2.725 | 0.886 |
| 4.875 | 3.625 | 0.744 |
| 6.30 | 4.80 | 0.762 |
| 7.85 | 6.15 | 0.783 |

Iso **AMYLAMINE HYDROCHLORIDE** $C_5H_{11}.NH_2.HCl$ (iso).

100 gms. $H_2O$ dissolve 192.2 gms. of the salt at 25°. (Peddle and Turner, 1913.)
100 gms. $CHCl_3$ dissolve 5.1 gms. of the salt at 25°.

Data for the distribution of ϵ-chloramyl amine between water and tetrachlorethane at 0°, water and nitrobenzene at 25° and water and benzene at 25° are given by Freundlich and Richards (1912).

**CHOLINE PERCHLORATE** and its Nitric Ether.

100 gms. $H_2O$ dissolve about 290 gms. $(CH_3)_3N(ClO_4)CH_2CH_2.OH$ at 15°.
100 gms. $H_2O$ dissolve 0.62 gm. $(CH_3)_3N(ClO_4)CH_2.CH_2.ONO_2$ at 15°.
100 gms. $H_2O$ dissolve 0.82 gm. " at 20°.
(Hofmann and Höbold, 1911.)

**NEURINE PERCHLORATE** $CH_2.CH.N(CH_3)_3OH\ HClO_4$.

100 gms. $H_2O$ dissolve 4.89 gms. of the salt at 14.5°. (Hofmann & Höbold, 1911.)

HEXA BROMO BENZENE $CBr_6$.

100 cc of 96% Ethyl Alcohol dissolve 0.0068 gm. $CBr_6$ at 20°.
100 cc of Methyl Alcohol (d = 07975) dissolve 0.076 gm. $CBr_6$ at 20°.

HEXA CHLORO BENZENE $CCl_6$.

100 gms. para cymene dissolve 2.93 gms. Hexachloro Benzene at 23°.5, 16.77 gms. at 100° and 106.95 gms. at 176°. (Wheeler, 1920.)
Freezing-point data for mixtures of α and β Hexachloro Benzene are given by Nagornow, 1911.

## TRI CHLORO TRI NITRO BENZENE $C_6Cl_3(NO_2)_2$.

### Reciprocal Solubility of Trichloro Trinitro Benzene and Hexamethyl Benzene.

(Hammick and Hellican, 1938.)

The determinations were made by the synthetic method.

| t° | Mol. fraction $C_6(CH_3)_6$ | Solid Phase | t° | Mol. fraction $C_6CH_3)_6$ | Solid Phase |
|---|---|---|---|---|---|
| 187.0 | 0.0 | $C_6Cl_3(NO_2)_3$ | 141.5 | 0.54 | $2C_6Cl_3(NO_2)_3C_6(CH_3)_6$ |
| 183.2 | 0.08 | " | 140.0 | 0.59 | " |
| 175.0 | 0.19 | " | 137.5 | 0.65 | " |
| 159.5 | 0.41 | " | 138.1 | 0.69 | $C_6(CH_3)_6$ |
| 155.0 | 0.46 | " | 146.5 | 0.79 | " |
| 146.9 | 0.52 | " | 154.5 | 0.89 | " |
| | | | 165.0 | 1.00 | " |

### Reciprocal Solubility of Trichloro Trinitro Benzene and Naphthalene.

(Hammick and Hellicar, 1938.)

| t° | Mol. fraction $C_{10}H_8$ | Solid Phase | t° | Mol. fraction $C_{10}H_8$ | Solid Phase |
|---|---|---|---|---|---|
| 187.0 | 0.0 | $C_6Cl_3(NO_2)_3$ | 129.8 | 0.52 | $2C_6Cl_3(NO_2)_3.C_{10}H_8$ |
| 183.0 | 0.07 | " | 130.0 | 0.55 | " |
| 171.2 | 0.20 | " | 127.2 | 0.59 | " |
| 158.3 | 0.31 | " | 108.9 | 0.71 | " |
| 149.8 | 0.37 | " | 89.0 | 0.80 | " |
| 135.0 | 0.48 | " + $2C_6Cl_3(NO_2)_3C_{10}H_8$ | 74.3 | 0.90 | $C_{10}H_8$ |
| 134.2 | 0.51 | $2C_6Cl_3(NO_2)_3.C_{10}H_8$ | 80.0 | 1.00 | " |

## TETRA CHLORO BENZENE $C_6H_2Cl_4$.

Freezing-point data for mixtures of tetrachloro benzene with ethylene chloride and with p dichloro benzene are given by Timmermans, 1934.

## TRI BROMO NITROSO BENZENE $C_6H_2Br_3NO$.

Freezing-point data for mixtures of tribromo nitroso benzene and nitroso mesitylene are given by Hammick, Edwards, Illingworth and Snell, 1933.

## 2.6 Dibrom **QUINONE** Chlor**IMIDE** $O:C_6H_2Br_2:NCl$.

1000 cc. sat. solution of 2.6 dibrom quinone chlorimide in water contain 0.0002 gm. mol. or 0.06 gm. $O:C_6H_2Br_2:NCl$ at 20°. (Gibbs, 1927.)

## 2.6 Dibrom **QUINONE OXIME** $O:C_6H_2Br:NOH$.

1000 cc. sat. solution of 2.6 dibrom quinone oxime in water contain 0.00085 gm. mol. or 0.2388 gm. $O:C_6H_2Br_2:NOH$ at 20°. (Gibbs, 1927 *a*.)

## TRICHLORO PHENOL $OHC_6H_2(2.4.6)Cl_3$.

Freezing-point data are given for:

Tri chloro phenol Di phenylamine (Giua and Cherchi, 1919.)
" " " Styphnic acid (Jänecke and Rahlfs, 1932.)

## PICRYL CHLORIDE $C_6H_2(2)Cl(1.3.5)(NO_2)_3$.

Freezing-point data are given for mixtures of Picryl Chloride and:

| | |
|---|---|
| Acenaphthene (1)(6) | Naphthalene (1)(2)(6) |
| Anthracene (1)(6) | Picric acid (1)(6) |
| Acenaphthylene (6) | Phenanthrene (6) |
| Benzene (3) | Pyrene (5) |
| Diphenyl butadien (4) | Retene (1)(6) |
| Fluorene (1)(6) | Tri nitro phenol (2) |
| Fluor anthene (5) | Tri nitro toluene (2) |

(1) Jefremow, 1918; (2) Grim, Gunther and Titus, 1931; (3) Hammick, Hill and Howard, 1932; (4) Kuhn and Wagner-Jouregg, 1921; (5) Shinomiya, 1940; (6) Efremov, 1918.

Results for mixtures of **Picryl Sulfide** and Tolite are given by Roche and Thomas, 1923.

## CHLORO TRI NITRO BENZENE $C_6H_2(1)Cl(2.4.6.)(NO_2)_3$.

### Solubility of 1 Chloro 2.4.6 Trinitro Benzene in Water.

(Desvergnes, 1925, 1931.)

| $t^0$ | Gms. $C_6H_2Cl(NO_2)_3$ per 100 gms. $H_2O$ |
|---|---|
| 15 | 0.0178 |
| 50 | 0.053 |
| 100 | 0.346 |

### Solubility of 1 Chloro 2.4.6 Trinitro Benzene in Organic Solvents.

(Desvergnes, 1925.)

| Solvent | Gms. $C_6H_2Cl(NO_2)_3$ per 100 gms. solvent at 17° | 50° | Solvent | Gms. $C_6H_2Cl(NO_2)_3$ per 100 gms. solvent at 17° | 50° |
|---|---|---|---|---|---|
| $CH_3COOC_2H_5$ | 91.52 | 238.35 | $CHCl_3$ | 12.36 | 233.42 |
| $(CH_3)_2CO$ | 212.00 | 546.43 | $C_5H_5N$ | 120.79 | 173.38(1) |
| $CH_3OH$ | 10.24 | 34.80 | $CCl_4$ | 0.56 | 2.45 |
| 96% $C_2H_5OH$ | 2.70 | 10.85 | $C_6H_5CH_3$ | 89.44 | 321.05 |
| 100% " | 4.85 | 15.06 | $(C_2H_5)_2O$ | 7.23 | 10.64(31°) |
| $C_6H_6$ | 36.69 | 428.08 | $CS_2$ | 0.50 | 0.95(30.5°) |

(1) The compound $2\,C_6H_2(NO_2)_3OH.5C_5H_5N$ is formed.

Results are also given for the freezing-points of mixtures of Chloro tri nitro benzene and Chloro 2.4 Di nitro benzene

## DICHLORO DINITRO BENZENES $C_6H_2Cl_2(NO_2)_2$.

Freezing-point data are given for:

1.3 Dichloro, 4.6 Dinitro Benzene + 1,3 Dichloro, 2.4 Dinitro Benzene. (Dann, 1929.)

1.4 Dichloro 2.5 Dinitro Benzene + 2,6 Dinitro Benzene. (Macleod, Pfund and Kilpatrick, 1922.)

## TETRA NITRO BENZENE $C_6H_2(NO_2)_4$.

Freezing-point data for mixtures of Tetra nitro Benzene and each of the following compounds: Acenaphthene, Anthracene, Fluorene, Phenanthrene, Pyrene, α and β Nitro Naphthalene, β Naphthyl Acetate and β Methyl Naphthoate are given by Shimoniya, 1940.

## TRI BROMO BENZENE $C_6H_3Br_3$.

100 gms. $H_2O$ dissolve 0.004 gm. $C_6H_3Br_3$ at 20-25°.
" " Pyridine dissolve 24.3 gm. $C_6H_3Br_3$ at 20-25°.
" " Aq. 50% Pyridine dissolve 2.01 gm. $C_6H_3Br_3$ at 20-25°.
(Dehn, 1917.)

## TRI CHLORO BENZENE $C_6H_3Cl_3$.

Freezing-point data for mixtures of 1.2.3, 1.2.4 and 1.3.5 tri chloro benzenes are given by Vander Linden, 1911, 1912.

## *s* Tribromo**PHENOL** $C_6H_2Br_3OH$.

Data for the solubility of mixtures of symmetrical tribromophenol and symmetrical trichlorophenol in diluted methyl alcohol at 25° are given by Küster and Würfel (1904-05). The results are presented in terms which are not clearly explained.

Solubility of Mixtures of *s* Tribromo Phenol and *s* Trichloro Phenol in Methyl Alcohol at 25°.
(Thiel, 1903; from Würfel, 1896.)

| Molecular per cent $C_6H_2.OH.Br_3$ | | *n* Solubility of | | Total. |
|---|---|---|---|---|
| In Solid. | In Solution. | $C_6H_2.OH.Cl_3$. | $C_6H_2.OH.Br_3$. | |
| 0 | 0 | 0.204 | 0 | 0.204 |
| 4.49 | 3.59 | 0.194 | 0.007 | 0.201 |
| 10.13 | 7.58 | 0.191 | 0.016 | 0.206 |
| 16.28 | 12.15 | 0.172 | 0.024 | 0.196 |
| 62.44 | 13.07 | 0.204 | 0.031 | 0.235 |
| 69.88 | 15.86 | 0.150 | 0.028 | 0.178 |
| 81.76 | 19.01 | 0.096 | 0.023 | 0.118 |
| 84.66 | 24.05 | 0.069 | 0.022 | 0.091 |
| 87.53 | 32.46 | 0.043 | 0.021 | 0.063 |
| 93.62 | 47.87 | 0.021 | 0.019 | 0.040 |
| 100.0 | 100.0 | 0.0 | 0.019 | 0.019 |

Freezing-point data are given for mixtures of:

s Tribromo phenol + s Trichloro phenol (Küster and Würfel, 1904-5.)
" " + s Trinitro benzene (Sudborough and Beard, 1911.)
" " + Acetyl tribromo phenol (Boeseken, 1912.)
" " + Tetra methyl phthalan (Bennett and Wain, 1936.)
s Trichloro " + " " " " " "
" " + Nitro benzene (Hrynakowski and Szmyt, 1938a.)
" " + Diphenyl amine (Giua and Cherchi, 1919.)

**DICHLORO NITRO BENZENE** $C_6H_3Cl_2(NO_2)$.

Freezing-point data for mixtures of 1.2.4 Dichloro nitro benzene and Naphthylamine are given by Giua, Marcellino and Curti, 1920.)

**CHLORO IODO NITRO BENZENES** $C_6H_3ClI(NO_2)$.

Binary freezing-point curves for mixtures of the iso meric chloro iodo nitrobenzenes are given by Wallagh and Wibaut, 1936.

**BROMO DINITRO BENZENE** $BrC_6H_3(2.4)(NO_2)_2$.

Freezing-point data are given for mixtures of Bromodinitro benzene and:

| | |
|---|---|
| Azoxy benzene | (Giua and Guastalla, 1925.) |
| Cinnamylidene acetophenone | (Giua, 1925.) |
| s Diethyl diphenyl urea | (Giua and Guastalla, 1925.) |

**CHLORO DINITRO BENZENES** 1.2.4-$C_6H_3Cl(NO_2)_2$.

SOLUBILITY OF 1 CHLORO 2.4 - DINITRO BENZENE IN WATER AND IN ORGANIC SOLVENTS.
(Desvergnes, 1925, 1931a.)

| Solvent | Gms. $C_6H_3ClNO_2$ per 100 gms. solvent at: 16° | 50° | Solvent | Gms. $C_6H_3ClNO_2$ per 100 gms. solvent at: 15° | 50° |
|---|---|---|---|---|---|
| $H_2O$ | 0.0008(15°) | 0.041 | $C_6H_6$ | 158.43 | 359.64(31°) |
| " | — | 0.159(100°) | $CHCl_3$ | 102.76 | 210.01(32°) |
| $CH_3COOC_2H_5$ | 119.42 | 257.51 | $(C_2H_5)_2O$ | 23.52 | 128.13(30.5°) |
| $(CH_3)_2CO$ | 267.90 | 531.90(30°) | $C_5H_5N$ | 26.33 | 20.85(1) |
| 96% $C_2H_5OH$ | 4.73 | 15.48(34°) | $CS_2$ | 4.21 | 28.87(31°) |
| 100% " | 8.25 | 18.89(32.5°) | $CCl_4$ | 3.85 | 76.99(31°) |
| $CH_3OH$ | 11.23 | 32.37(32°) | $C_6H_5CH_3$ | 139.89 | 282.55(31.5°) |

(1) With formation of 2.4 dinitro phenyl pyridinium chloride.

Freezing-point data are given for:

| | | |
|---|---|---|
| 1.2.4 Chloro Dinitro Benzene | 2.6 Dinitrobenzene | (Macleod, Pfund and Kilpatrick, 1922.) |
| " " " " | + Benzantial doxime | (Brady and Truszkowski, 1924.) |
| " " " " | + o Hydroxy " | " " " |
| " " " " | + o Methoxy " | " " " |
| " " " " | + p " " | " " " |
| " " " " | + " " benzsynal doxime | " " |
| " " " " | + p Amino acetophenone | (Giua, Marcellino and Curti, 1920.) |
| " " " " | + Naphthylamine | (Giua and Marcellino, 1920.) |
| " " " " | + o & m Nitro aniline | " |
| " " " " | + Nitromannite | (Urbanski, 1933.) |
| " " " " | + Nitro penta erythrite | " |

## TRINITRO BENZENE 1.3.5 $C_6H_3(NO_2)_3$.

### Solubility of 1.3.5 Trinitro Benzene in Water and in Organic Solvents.

(Desvergnes, 1925, 1931.)

| Solvent | Gms. $C_6H_3(NO_2)_3$ per 100 gms. solvent at 17° | 50° | Solvent | Gms. $C_6H_3(NO_2)_3$ per 100 gms. solvent at 17° | 50° |
|---|---|---|---|---|---|
| $H_2O$ | 0.0278(15°) | 0.102 | $C_6H_6$ | 6.18 | 25.70 |
| " | — | 0.498(100°) | $CHCl_3$ | 6.24 | 18.42 |
| $CH_3COOC_2H_5$ | 29.83 | 52.40 | $(C_2H_5)_2O$ | 1.70 | 2.72(32.5°) |
| $(CH_3)_2CO$ | 59.11 | 160.67 | $C_5H_5N$ | 112.61 | 194.23 |
| 96% $C_2H_5OH$ | 1.39 | 3.52 | $CS_2$ | 0.24 | 0.44(33°) |
| 100% " | 2.09 | 4.57 | $CCl_4$ | 0.24 | 0.69 |
| $CH_3OH$ | 3.76 | 7.62 | $C_6H_5CH_3$ | 11.82 | 76.31 |

### Solubilities of Di-Nitro **BENZENES** and of Tri-Nitro **BENZENES** in Several Solvents.

(de Bruyn — Rec. trav. chim. 13, 116, 150, '94.)

| Solvent. | t°. | Grams per 100 Grams Solvent. (*o*)$C_6H_4(NO_2)_2$. | (*m*)$C_6H_4(NO_2)_2$. | (*p*)$C_6H_4(NO_2)_2$. | (*s*)$C_6H_3(NO_2)_3$. | (*as*)$C_6H_3(NO_2)_3$. |
|---|---|---|---|---|---|---|
| Methyl Alcohol | 20.5 | 3.30 | 6.75 | 0.69 | 4.9 (16°) | 16.2 (15.5°) |
| Ethyl Alcohol | 20.5 | 1.9 | 3.5 | 0.4 | 1.9 (16°) | 5.45 (15.5°) |
| Propyl Alcohol | 20.5 | 1.09 | 2.4 | 0.298 | ... | ... |
| Carbon Bi-Sulphide | 17.6 | 0.236 | 1.35 | 0.148 | 0.25 | ... |
| Chloroform | 17.6 | 27.1 | 32.4 | 1.82 | 6.1 | ... |
| Benzene | 18.2 | 5.66 | 39.45 | 2.56 | 6.2 (16°) | ... |
| Ether | 17.5 | ... | ... | ... | 1.5 | ... |
| Ethyl Acetate | 18.2 | 12.96 | 36.27 | 3.56 | ... | ... |
| Toluene | 16.2 | 3.62 | 30.66 | 2.36 | ... | ... |
| Carbon Tetra Chloride | 16.2 | 0.143 | 1.18 | 0.12 | ... | ... |
| Water | (ord.) | 0.014 | 0.0525 | 0.008 | ... | ... |

### Symmetrical Tri-Nitro **BENZENE**.

#### Solubility in Aqueous Alcohol at 25°.

(Holleman and Antusch — Rec. trav. chim. 13, 296, '94.)

| Vol. % Alcohol. | G. $C_6H_3(NO_3)_3(s)$ per 100 g. Solvent. | Sp. Gr. of Solutions. | Vol. % Alcohol. | G. $C_6H_3(NO_3)_3(s)$ per 100 g. Solvent. | Sp. Gr. of Solutions. |
|---|---|---|---|---|---|
| 100 | 2.34 | 0.7957 | 80 | 0.57 | 0.8582 |
| 95 | 1.57 | 0.8131 | 75 | 0.47 | 0.8708 |
| 90 | 1.12 | 0.8288 | 70 | 0.37 | 0.8808 |
| 85 | 0.79 | 0.8436 | 60 | 0.23 | 0.9064 |

See remarks under α Acetnaphthalide, p. 705

100 gms. 93 vol. % ethyl alcohol dissolve 2.1 gms. of *o* $C_6H_4(NO_2)_2$, 3.1 gms. *m* $C_6H_4(NO_2)_2$ and 0.33 gm. *p* $C_6H_4(NO_2)_2$ at 25°. (Holleman and de Bruyn, 1900.)

100 gms. of each of the following solvents dissolve the indicated gms. of 1.2.4 trinitrobenzene at 15.5°: $C_6H_6$, 140.8 gms.; $CHCl_3$, 12.87 gms.; $CH_3OH$, 12.08 gms.; $(C_2H_5)_2O$, 7.13 gms.; $C_2H_5OH$, 5.42 gms; $CS_2$, 0.4 gm. (de Bruyn, 1890.)

Data for the solubility of *m* dinitrobenzene in a solution of nitrobenzene in hexane are given by Timmermans (1907).

Freezing-point data are given for mixtures of Trinitro Benzene and each of the following compounds:

Acenaphthene(1)
Anthracene(4)
Aniline(2)
" o bromo(17)
Benzene(10)
Carbazole(1)
Coumarine(8)
m Dinitro benzene(18)
Dimethyl pyrone(8)
yy Dipyridyl(6)
Diphenyl(19)
Fluorenone(3)(8)
Fluorene(3)
Fluoranthene(5)
Iodo diphenyl(20)
β Methyl naphthoate(5)
Naphthalene(2)
β Naphthyl acetate(5)
α and β Naphthylamine (12)(13)(14)
m Nitraniline(6)(7)
p " (6)(7)
Nitrobenzene(18)
Nitro mannite(21)
α Nitro naphthalene(5)
β " " (5)
Nitro penta erythritol(21)
o,m and p Phenylene diamine(15)
Phenyl ether(8)
Pyrene(5)
Quinol(8)
Styphnic acid(16)
Tribrom phenol(8)
Trinitro phenyl methyl nitramine(22)
Triphenyl carbinole(11)
Urea(9)
Xanthone(8)
Phenanthrene(23)

(1) Kremann and Strzelba, 1921; (2) Kremann, 1904; (3) Kremann, 1911; (4) Kremann and Müller II, 1921; (5) Shinomiya, 1940; (6) Smith and Watts, 1910; (7) Sudborough and Beard, 1910; (8) Sudborough and Beard, 1911; (9) Van Dorp, Limburg and Nobel, 1937; (10) Hammick, Hills and Howard, 1932; (11) Kremann, Kohl and Müller II, 1921; (12) Kremann and Grasser, 1916; (13) Rheinboldt and Kircheisen, 1926 (14) Rheinboldt, Henning and Kircheisen, 1925; (15) Kremann and Mauermann, 1923; (16) Efremov, 1919a; (17) Hertel, 1924; (18) Hammick, Andrew and Hampson, 1923; (19) Briegleb and Schachowskoy, 1932; (20) Pfeiffer, Schuntz and Inoue, 1929; (21) Urbanski, 1933; (22) Jefremow and Bogojawlenski, 1926.
(23) Kremann, et. al., 1908.

**PICRIC ACID** $C_6H_2.OH.(NO_2)_3$ 1.2.4.6.

SOLUBILITY IN WATER.

(Dolinski — Ber. 38, 1836, '05; Findlay — J. Ch. Soc. 81, 1219, '02.)

| t°. | Gms. $C_6H_3N_3O_7$ per 100 Grams Solution. | Gms. $C_6H_3N_3O_7$ per 100 Grams Water. | |
|---|---|---|---|
| 0 | 0.67 (D.) | 0.68 (D.) | 1.05 (F.) |
| 10 | .80 | 0.81 | 1.10 |
| 20 | 1.10 | 1.11 | 1.22 |
| 30 | 1.38 | 1.40 | 1.55 |
| 40 | 1.75 | 1.78 | 1.98 |
| 50 | 2.15 | 2.19 | 2.53 |
| 60 | 2.77 (D.) | 2.81 (D.) | 3.17 (F.) |
| 70 | 3.35 | 3.47 | 3.89 |
| 80 | 4.22 | 4.41 | 4.66 |
| 90 | 5.44 | 5.72 | 5.49 |
| 100 | 6.75 | 7.24 | 6.33 |

Dolinski does not refer to the previous determinations of Findlay.

100 gms. $H_2O$ dissolve 1.525 gms. $C_6H_2.OH.(NO_2)_3$ at 30° and 1.868 gms. at 40°. (Karplus, 1907.)

100 gms. $H_2O$ dissolve 1.45 gms. $C_6H_2.OH.(NO_2)_3$ at 20°. (Sisley, 1902.)

100 gms $H_2O$ containing 5 gms. $H_2SO_4$ per liter, dissolve 0.61 gm. $C_6H_2OH(NO_2)_3$ at 20°. (Sisley, 1902.)

## Solubility of 1.2.4.6 Trinitro Phenol (Picric Acid) in Water.

(Desvergnes, 1927.)

| t° | Gms. $C_6H_2OH(NO_2)_3$ per 100 gms. $H_2O$ | t° | Gms. $C_6H_2OH(NO_2)_3$ per 100 gms. $H_2O$ |
|---|---|---|---|
| 9 | 0.979 | 82 | 4.691 |
| 50 | 2.328 | 100 | 7.600 |

In addition to the above, the following determinations at 20° and 25° have been made.

| t° | Gm. Mol. $C_6H_2OH(NO_3)_2$ per liter | Authority | t° | Gm. Mol. $C_6H_2OH(NO_3)_2$ per liter | Authority |
|---|---|---|---|---|---|
| 20 | 0.0515 | (Brönsted, 1912.) | 25 | 0.0552 | (Flatt and Jorday, 1933.) |
| " | 0.0530 | (Marchand, 1909.) | " | 0.0568 | (v. Halban and Kortschak, 1938.) |
| " | 0.0535 | (Erday-Gruz, 1928.) | " | 0.0570 | (Duff and Bills, 1931.) |
| " | 0.0568 | (v. Halban and Kortschak, 1938.) | " | 0.0575 | (Schreiner, 1924.) |
| 25 | 0.0487 | (Sala and Kurano, 1933.) | " | 0.0578 | (Knox and Richards, 1918.) |
| " | 0.0533 | (Levin, 1906.) | " | 0.0581 | (Jorissen and Rutter, 1905.) |
| " | 0.0533 | (Drucker, 1929.) | | | |

## Solubility of Picric Acid in Aqueous Solutions of Hydrochloric Acid at 25°.

(Stepanow, 1910.)

(The solutions were saturated by constant agitation at constant temperature. The picric acid in the saturated solutions was determined by evaporation and weighing. The solubility passes through a minimum.)

| Mols. HCl per Liter. | $C_6H_2.OH.(NO_2)_3$ per Liter. | | Mols. HCl per Liter. | $C_6H_2.OH.(NO_2)_3$ per Liter. | |
|---|---|---|---|---|---|
| | Mols. | Gms. | | Mols. | Gms. |
| 0.25 | 0.0116 | 2.66 | 3.67 | 0.0068 | 1.55 |
| 0.50 | 0.0079 | 1.80 | 4.40 | 0.0082 | 1.87 |
| 0.75 | 0.0062 | 1.42 | 5.14 | 0.0098 | 2.26 |
| 1 | 0.0054 | 1.24 | 5.51 | 0.0105 | 2.41 |
| 1.47 | 0.0050 | 1.14 | 5.87 | 0.0115 | 2.65 |
| 2.20 | 0.0051 | 1.15 | 6.24 | 0.0123 | 2.82 |
| 2.94 | 0.0057 | 1.31 | 6.61 | 0.0125 | 2.86 |

## Solubility of Picric Acid in Aqueous Solutions of Several Salts at 25°. (Schreiner, 1924.)

Saturation was secured by constant rotation.

Results for aqueous solutions of :

Barium chloride.

| Gm. mols. per liter | |
|---|---|
| $BaCl_2$. | $OH.C_6H_2(NO_2)_3$. |
| 0.00 | 0.0575 |
| 0.01 | 0.0599 |
| 0.03 | 0.0618 |
| 0.05 | 0.0683 |
| 0.07 | 0.0691 |
| 0.10 | 0.0720 |

Magnesium sulfate.

| Gm. mols. per liter | | Gm. mols. per liter | |
|---|---|---|---|
| $MgSO_4$. | $OH.C_6H_2(NO_2)_3$. | $MgSO_4$. | $OH.C_6H_2(NO_2)_3$. |
| 0.00 | 0.0575 | 0.13 | 0.0830 |
| 0.01 | 0.0626 | 0.15 | 0.0859 |
| 0.03 | 0.0680 | 0.17 | 0.0888 |
| 0.05 | 0.0720 | 0.20 | 0.0916 |
| 0.07 | 0.0752 | 0.35 | 0.1052 |
| 0.10 | 0.0796 | 0.50 | 0.1159 |

Sodium chloride.

| Gm. mols. per liter | |
|---|---|
| NaCl. | $OH.C_6H_2(NO_2)_3$. |
| 0.01 | 0.0584 |
| 0.03 | 0.0602 |
| 0.05 | 0.0614 |
| 0.07 | 0.0624 |
| 0.10 | 0.0633 |
| 0.30 | 0.0659 |

## Solubility of Picric Acid in Aqueous Solutions of Nitric Acid at 25°.

(Knox and Richards, 1919.)

| Equiv. Normalities | |
|---|---|
| $HNO_3$. | $OH.C_6H_2(NO_2)_3$. |
| 0.00 | 0.0578 |
| 1.022 | 0.0108 |
| 2.059 | 0.0124 |

| Equiv. Normalities | |
|---|---|
| $HNO_3$. | $OH.C_6H_2(NO_2)_3$. |
| 4.161 | 0.0237 |
| 6.289 | 0.0405 |
| 8.334 | 0.0612 |

| Equiv. Normalities | |
|---|---|
| $HNO_3$. | $OH.C_6H_2(NO_2)_3$. |
| 10.47 | 0.1006 |
| 12.47 | 0.1763 |
| 14.29 | 0.3533 |

## Solubility of Picric Acid in Aqueous Solutions of Acids at 25°.

(Drucker, 1929.)

| In aqueous HCl | | In aqueous $HNO_3$ | | In aqueous $H_2SO_4$ | |
|---|---|---|---|---|---|
| Gm. Equiv. per liter | | Gm. Equiv. per liter | | Gm. Equiv. per liter | |
| HCl | $C_6H_2OH(NO_2)_3$ | $HNO_3$ | $C_6H_2OH(NO_2)_3$ | $H_2SO_4$ | $C_6H_2OH(NO_2)_3$ |
| 0.01425 | 0.0457 | 0.00635 | 0.05095 | 0.00577 | 0.05023 |
| 0.02664 | 0.0409 | 0.02564 | 0.04281 | 0.02197 | 0.04530 |
| 0.04594 | 0.03596 | 0.05166 | 0.03493 | 0.03758 | 0.03934 |
| 0.1159 | 0.02223 | 0.0872 | 0.02604 | 0.1022 | 0.02740 |

## Solubility of Picric Acid in Water and in Aqueous Salt Solutions at 25°.

(Levin — Z. physik. Ch. 55, 520, '06.)

One liter of aqueous solution contains 0.05328 gram mols. = 12.20 grams $C_6H_2.OH(NO_2)_3$ at 25°.

| Gm. Mols. Salt per Liter. | Gram Mols. Picric Acid per Liter in Aq. Solutions of: | | | | | |
|---|---|---|---|---|---|---|
| | NaCl. | $NaNO_3$. | $Na_2SO_4$. | LiCl. | $Li_2SO_4$. | $NH_4Cl$. |
| 0.01 | 0.05524 | 0.05529 | 0.05604 | 0.05480 | 0.05661 | 0.05487 |
| 0.02 | 0.05559 | | 0.05872 | 0.05558 | 0.06053 | 0.05540 |
| 0.05 | 0.05729 | | 0.06632 | 0.05703 | 0.06691 | 0.05771 |
| 0.07 | 0.05862 | | 0.07093 | 0.05878 | 0.07013 | 0.05865 |
| 0.10 | 0.05902 | | 0.07670 | 0.06132 | 0.07437 | ... |
| 0.50 | 0.0790 | | ... | ... | 0.123 | ... |
| 1.00 | 0.1180 | | ... | ... | 0.149 | ... |

| Gm. Mols. Salt per Liter. | Grams Picric Acid per Liter in Aq. Solutions of: | | | | | |
|---|---|---|---|---|---|---|
| | NaCl. | $NaNO_3$. | $Na_2SO_4$. | LiCl. | $Li_2SO_4$. | $NH_4Cl$. |
| 0.01 | 12.66 | 12.67 | 12.83 | 12.55 | 12.97 | 12.57 |
| 0.02 | 12.74 | | 13.45 | 12.74 | 13.87 | 12.69 |
| 0.05 | 13.12 | | 15.19 | 13.06 | 15.33 | 13.22 |
| 0.07 | 13.43 | | 16.25 | 13.47 | 16.06 | 13.44 |
| 0.10 | 13.52 | | 17.57 | 14.05 | 17.04 | ... |
| 0.50 | 18.09 | | ... | ... | 28.18 | ... |
| 1.00 | 26.98 | | ... | ... | 34.14 | ... |

### Solubility in Aq. Cane Sugar.

| Gm. Mols. Sugar per Liter. | Picric Ac. per Liter Solution. | | Sp. Gr. Solution. |
|---|---|---|---|
| | Gm. Mols. | Gms. | |
| 0.10 | 0.05202 | 11.92 | 1.0122 |
| 0.25 | 0.04978 | 11.40 | 1.0319 |
| 0.50 | 0.0482 | 11.04 | 1.0654 |
| 1.00 | 0.0443 | 10.15 | 1.1294 |

### Solubility in Aq. Grape Sugar.

| Gm. Mols. Grape Sugar per Liter. | Picric Acid per Liter Sol. | |
|---|---|---|
| | G. Mols. | Gms. |
| 0.10 | 0.0530 | 12.14 |
| 0.25 | 0.0521 | 11.93 |
| 0.50 | 0.0509 | 11.66 |
| 1.00 | 0.0474 | 10.86 |

## Solubility of Picric Acid in Aqueous Solutions of Sodium Chloride at 25°.

(Kozakewitch and Mikhalkow, 1934.)

| Gm. Mols. NaCl per liter aq. solvent | Gm. Mols. $C_6H_2OH(NO_2)_3$ per liter sat. sol. |
|---|---|
| 0.30 | 0.0659 |
| 0.40 | 0.0734 |
| 0.60 | 0.0437 |
| 0.80 | 0.0280 |
| 1.00 | 0.209 |

## PICRIC ACID

### Solubility of Picric Acid in Aqueous Acid and Salt Solutions at 20°.

(v. Halban and Kortschak, 1938.)

The picric acid was determined by titration with barium hydroxide solution using phenolphthaline as indicator.

| Conc. of aq. solvent in gm. equiv. per liter | Gm. Mol. $C_6H_2OH(NO_2)_3$ per liter sat. sol. | Conc. of aq. solvent in gm. equiv. per liter | Gm. Mol. $C_6H_2OH(NO_2)_3$ per liter sat. sol. |
|---|---|---|---|
| 0.0000 (= $H_2O$) | 0.05151 | 0.01856 $CaCl$ | 0.05424 |
| 0.00944 $NaCl$ | 0.05247 | 0.04071 " | 0.05618 |
| 0.02773 " | 0.05325 | 0.1240 " | 0.05934 |
| 0.04643 " | 0.05416 | 0.2108 " | 0.06083 |
| 0.07362 " | 0.05533 | 0.2507 " | 0.06112 |
| 0.1289 " | 0.05695 | 0.3072 " | 0.06170 |
| 0.2754 " | 0.05858 | 0.4709 " | 0.06101 |
| 0.3143 " | sat. | 0.8170 " | 0.05866 |
| 0.02296 $NaBr$ | 0.05344 | 1.167 " | 0.05360 |
| 0.1078 " | 0.05708 | 1.489 " | 0.04785 |
| 0.2330 " | 0.05898 | 2.316 " | 0.01346 |
| 0.00853 $NaClO_4$ | 0.05240 | 0.01690 $Ca(NO_3)_2$ | 0.05564 |
| 0.03186 " | 0.05520 | 0.03477 " | 0.05813 |
| 0.06792 " | 0.05728 | 0.1118 " | 0.06434 |
| 0.09938 " | 0.05912 | 0.1231 " | 0.06480 |
| 0.3177 " | 0.06716 | 0.1738 " | 0.06618 |
| 0.01908 $NaNO_3$ | 0.05330 | 0.2484 " | 0.06845 |
| 0.04891 " | 0.05508 | 0.3400 " | 0.07015 |
| 0.09000 " | 0.05712 | 0.6909 " | 0.06955 |
| 0.1870 " | 0.06106 | 0.00849 $Sr(NO_3)_2$ | 0.05401 |
| 0.3667 " | 0.06322 | 0.0200 " | 0.05575 |
| 0.00664 $LiCl$ | 0.05250 | 0.04575 " | sat. |
| 0.00901 " | 0.05258 | 0.02438 $HCl$ | 0.03802 |
| 0.02050 " | 0.05308 | 0.1062 " | 0.02056 |
| 0.02791 " | 0.05309 | 0.2930 " | 0.00986 |
| 0.05841 " | 0.05392 | 0.5906 " | 0.006075 |
| 0.1285 " | 0.05538 | 1.108 " | 0.004572 |
| 0.5415 " | 0.05251 | 2.202 " | 0.004511 |
| 1.088 " | 0.04453 | 3.171 " | 0.004948 |
| 2.707 " | 0.02299 | 4.802 " | 0.007048 |
| 0.0422 $LiBr$ | 0.05356 | 0.03615 $HClO_4$ | 0.03549 |
| 0.1070 " | 0.05538 | 0.0859 " | 0.01737 |
| 0.1936 " | 0.05636 | 0.2291 " | 0.01360 |
| 0.4136 " | 0.05549 | 1.051 " | 0.01069 |
| 0.7336 " | 0.05136 | 1.730 " | 0.01490 |
| 1.178 " | 0.04354 | 2.292 " | 0.01842 |
| 0.01801 $LiClO_4$ | 0.05282 | 0.03031 $HNO_3$ | 0.03386 |
| 0.06604 " | 0.05527 | 0.0411 " | 0.03011 |
| 0.1052 " | 0.05702 | 0.1246 " | 0.02033 |
| 0.1951 " | 0.05784 | 0.2369 " | 0.01457 |
| 0.4279 " | 0.06056 | 0.3641 " | 0.01039 |
| 0.02156 $LiNO_3$ | 0.05288 | 0.783 " | 0.00829 |
| 0.05306 " | 0.05496 | 0.8533 " | 0.00961(1) |
| 0.09266 " | 0.05625 | 0.9647 " | 0.01038(1) |
| 0.1256 " | 0.05723 | 0.983 " | 0.00804(1) |
| 0.2723 " | 0.05984 | 1.039 " | 0.00834(1) |
| 0.4973 " | 0.06084 | 1.487 " | 0.00882(1) |
| 0.5674 " | 0.06114 | 1.681 " | 0.01325(1) |
| 0.6943 " | 0.06114 | 1.742 " | 0.00946(1) |
| 1.091 " | 0.05976 | | |
| 1.322 " | 0.05840 | | |

(1) Incomplete equilibrium.

## Solubility of Picric Acid in Aqueous Solutions of Methyl Alcohol.

(Duff and Bills, 1931.)

| Gms. $CH_3OH$ per 100 gms. aq. solvent | Gms. $C_6H_2OH(NO_2)_3$ per 100 gms. solvent at: | | |
|---|---|---|---|
| | 0° | 14° | 25° |
| 0.0 | 0.7 | 1.1 | 1.3 |
| 30.0 | 1.1 | 1.8 | 2.4 |
| 40.0 | 1.6 | 2.4 | 3.3 |
| 60.0 | 3.9 | 5.3 | 7.1 |
| 70.0 | 5.5 | 7.3 | 9.6 |
| 80.0 | 7.6 | 9.6 | 12.4 |
| 90.0 | 10.6 | 12.3 | 16.0 |
| 100.0 | 13.8 | 16.3 | 21.1 |

## Solubility of Picric Acid in Aqueous Solutions of Ethyl Alcohol.

(Duff and Bills, 1931.)

| Gms. $C_2H_5OH$ per 100 gms. aq. solvent | Gms. $C_6H_2OH(NO_2)_3$ per 100 gms. solvent at: | | | | | |
|---|---|---|---|---|---|---|
| | 0° | 12° | 14° | 25° | 40° | 50° |
| 0.0 | 0.7 | — | 1.1 | 1.3 | 1.9 | 2.4 |
| 30.0 | 1.2 | 2.0 | 1.9 | 3.1 | 4.6 | 6.5 |
| 40.0 | 2.0 | 2.9 | 3.8 | 5.3 | 7.35 | 10.0 |
| 60.0 | 5.6 | 4.9 | 7.6 | 10.5 | 13.5 | 17.4 |
| 78.0 | 8.9 | 6.8 | 11.1 | 13.6 | 17.95 | 22.5 |
| 80.0 | 9.1 | 7.1 | 11.5 | 13.8 | 18.3 | 22.8 |
| 81.0 | 9.3 | 7.3 | 11.4 | 13.8 | 18.3 | 22.8 |
| 85.0 | 9.0 | 7.9 | 11.0 | 13.2 | 17.6 | 22.3 |
| 90.0 | 8.1 | 8.6 | 10.2 | 12.3 | 16.6 | 21.1 |
| 100.0 | 4.5 | 10.4 | 6.0 | 8.0 | 11.0 | 14.8 |

The results at 12° are calculated from the determinations of Angelescu and Dumitrescu, 1928.

## Solubility of Picric Acid in Aqueous Solutions of Ethyl Alcohol at 25°.

Results of (Flatt and Jordan, 1933.)

| Gms. $C_2H_5OH$ per 100 gms. solvent | Gms. $C_6H_2OH(NO_2)_3$ per 100 gms. sat. solution | Gms. $C_6H_2OH(NO_2)_3$ per 100 gms. solvent |
|---|---|---|
| 0.0 | 1.252 | 1.268 |
| 8.05 | 1.480 | 1.502 |
| 20.4 | 2.102 | 2.147 |
| 42.5 | 5.995 | 6.377 |
| 67.9 | 11.36 | 12.82 |

Results of (Mahieu, 1936.)

| Gms. $C_2H_5OH$ per 100 gms. solvent | Gms. $C_6H_2OH(NO_2)_3$ per 100 gms. solvent |
|---|---|
| 0.0 | 1.27 |
| 25.6 | 2.40 |
| 54.0 | 5.29 |
| 67.9 | 12.92 |
| 80.0 | 14.34 |
| 100.0 | 7.79 |

## Solubility of Picric Acid in Aqueous Solutions of Normal Propyl Alcohol.

(Duff and Bills, 1931.)

| Gms. $C_3H_7OH$ per 100 gms. aq. solvent | Gms. $C_6H_2OH(NO_2)_3$ per 100 gms. solvent at: 0° | 25° | 50° |
|---|---|---|---|
| 0 | 0.7 | 1.3 | 2.4 |
| 30 | 2.8 | 5.0 | 9.7 |
| 40 | 4.5 | 7.2 | 12.4 |
| 60 | 7.1 | 10.9 | 18.0 |
| 75 | 8.1 | 12.2 | 19.1 |
| 80 | 8.2 | 12.0 | 19.0 |
| 85 | 7.9 | 10.8 | 17.4 |
| 90 | 6.0 | 9.4 | 15.7 |
| 95 | 4.4 | 7.0 | 12.6 |
| 100 | 2.4 | 3.7 | 7.5 |

## Solubility of Picric Acid in Aqueous Solutions of Iso Propyl Alcohol.

(Duff and Bills, 1931.)

| Gms. 1 $C_3H_7OH$ per 100 gms. aq. solvent | Gms. $C_6H_2OH(NO_2)_3$ per 100 gms. solvent at 0° | 25° | 40° | 50° |
|---|---|---|---|---|
| 0 | 0.7 | 1.3 | 1.9 | 2.4 |
| 30 | 1.5 | 3.8 | 4.7 | 6.4 |
| 40 | 3.3 | 5.9 | 8.0 | 9.5 |
| 60 | 6.9 | 10.3 | 13.7 | 17.8 |
| 70 | 8.5 | 12.0 | 16.0 | 20.1 |
| 75 | 9.1 | 12.7 | 16.8 | 20.8 |
| 80 | 9.7 | 13.4 | 17.4 | 21.3 |
| 82 | 9.6 | 13.4 | 17.5 | 21.5 |
| 85 | 9.5 | 13.1 | 17.0 | 21.2 |
| 90 | 9.2 | 12.6 | 16.4 | 20.4 |
| 95 | 7.8 | 11.1 | 15.0 | 18.0 |
| 100 | 5.8 | 8.7 | 12.0 | 15.4 |

## Solubility of Picric Acid in Aqueous Solutions of Acetone at 25°.

(Duff and Bills, 1931.)

| Gms. $(CH_3)_2CO$ per 100 gms. aq. solvent | Gms. $C_6H_2OH(NO_2)_3$ per 100 gms. aq. solvent | Gms. $(CH_3)_2CO$ per 100 gms. aq. solvent | Gms. $C_6H_2OH(NO_2)_3$ per 100 gms. aq. solvent |
|---|---|---|---|
| 0 | 1.3(2.9) | 70 | 65.8(44.0) |
| 30 | 9.5(7.9) | 80 | 87.8(70.0) |
| 40 | 18.9(12.1) | 90 | 110.8(107.0) |
| 50 | 31.3(20.0) | 100 | 134.3(194.2) |
| 60 | 46.7(29.0) | | |

The results in parentheses are calculated from the determinations at 12° of Angelescu and Dumitrescu, 1928.

## Solubility of Picric Acid in Aqueous Solutions of Organic Compounds.

(Erdey-Gruz, 1928.)

| Solvent, Aqueous 1.0 gm. mol. solution of: | Gms. $C_6H_2OH(NO_2)_3$ per 100 cc. aq. solvent |
|---|---|
| Glycerol | 1.119 |
| Mannitol | 1.065 |
| Chloral hydrate | 1.597 |
| Glucose (dextrose) | 1.035 |
| Sucrose (cane sugar) | 1.161 |

## Distribution of Picric Acid at 25° between:

### Water and Bromoform.

(Herz and Lewy — Z. Electrochem. 11, 820, '05.)

| Millimols $C_6H_3N_3O_7$ per 10 cc. | | Gms. $C_6H_3N_3O_7$ per 100 cc. | |
|---|---|---|---|
| Aq. Layer. | Bromoform Layer. | Aq. Layer. | Bromoform Layer. |
| 0.321 | 0.365 | 0.736 | 0.836 |
| 0.401 | 0.515 | 0.919 | 1.180 |
| 0.475 | 0.655 | 1.088 | 1.501 |
| 0.575 | 0.871 | 1.317 | 1.995 |
| 0.674 | 1.14 | 1.545 | 2.612 |

### Water and Chloroform.

(H. and L.)

| Millimols $C_6H_3N_3O_7$ per 10 cc. | | Gms. $C_6H_3N_3O_7$ per 100 cc. | |
|---|---|---|---|
| Aq. Layer. | Chloroform Layer. | Aq. Layer. | Chloroform Layer. |
| 0.207 | 0.254 | 0.474 | 0.582 |
| 0.329 | 0.547 | 0.754 | 1.253 |
| 0.488 | 1.09 | 1.118 | 2.498 |
| 0.561 | 1.41 | 1.285 | 3.230 |
| 0.588 | 1.53 | 1.348 | 3.505 |

## Distribution of Picric Acid at 25° between:

### Water and Amyl Alcohol.

(Herz and Fischer — Ber. 37, 4747, '04.)

| Millimols $C_6H_3N_3O_7$ per 10 cc. | | Gms. $C_6H_3N_3O_7$ per 100 cc. | |
|---|---|---|---|
| Aq. Layer. | Alcohol Layer. | Aq. Layer. | Alcohol Layer. |
| 0.0553 | 0.0930 | 0.127 | 0.213 |
| 0.0920 | 0.1850 | 0.211 | 0.424 |
| 0.1613 | 0.4127 | 0.369 | 0.946 |
| 0.1869 | 0.5182 | 0.428 | 1.188 |
| 0.3161 | 1.079 | 0.724 | 2.473 |
| 0.4471 | 1.638 | 1.024 | 3.753 |
| 0.5624 | 2.189 | 1.288 | 5.017 |
| 0.6423 | 2.549 | 1.472 | 5.839 |

### Water and Toluene.

(H. and F. — Ber. 38, 1142, '05.)

| Millimols $C_6H_3N_3O_7$ per 10 cc. | | Gms. $C_6H_3N_3O_7$ per 100 cc. | |
|---|---|---|---|
| Aq. Layer. | Toluene Layer. | Aq. Layer. | Toluene Layer. |
| 0.075 | 0.126 | 0.172 | 0.289 |
| 0.109 | 0.230 | 0.250 | 0.527 |
| 0.163 | 0.482 | 0.374 | 1.104 |
| 0.244 | 1 026 | 0.559 | 2.351 |
| 0.389 | 2.347 | 0.891 | 5.380 |
| 0.496 | 3.747 | 1.137 | 8.586 |
| 0.583 | 5.135 | 1.336 | 11.770 |

Additional data for the distribution of picric acid between water and amyl alcohol and water and toluene at 20° are given by Sisley (1902). Very irregular results were obtained. The fact that the colors of the two layers are different, was taken to indicate that the picric acid dissolves in a different molecular form in the two layers.

## Distribution of Picric Acid between:

### Water and Benzene. (Kuriloff, 1898.)

| Mols. Picric Acid per Liter: | |
|---|---|
| Aq. Layer. | $C_6H_6$ Layer. |
| 0.0261 | 0.0940 |
| 0.0208 | 0.0779 |
| 0.0188 | 0.0618 |
| 0.0132 | 0.0359 |
| 0.0097 | 0.0198 |

### Water and Ether at 20°. (Sisley, 1902.)

| Gms. Picric Acid per Liter: | | Dist. Coef. |
|---|---|---|
| Aq. Layer. | Ether Layer. | |
| 6.78 | 17.85 | 2.63 |
| 3.74 | 6.70 | 1.79 |
| 2.85 | 3.72 | 1.34 |
| 0.85 | 0.11 | 0.13 |
| 0.10 | 0.001 | 0.01 |

Additional results for the distribution of picric acid between water and benzene are given by Rothmund and Ducker, 1903.

Data for the distribution of picric acid between water and mixtures of chloroform and toluene at 25°, are given by Herz and Kurzer, 1910.

## Distribution of Picric Acid Between Benzene and Mixtures of Light and Heavy Water at 18°.

(Gross and Wischin, 1936.)

A 0.02979 molal solution of picric acid in benzene was used for all experiments. Picric acid was determined by titration using phenolphthaleine as indicator. Micro pipets were used for measuring the volumes. The $D_2O$ percentage of the water was determined by density measurements. One cc. of water was shaken with 1 cc. of the standard picric acid solution in benzene in sealed tubes. After equilibrium was attained 0.5 cc of each layer was titrated.

| d 18/18 of $D_2O + H_2O$ | Mol. fraction of $D_2O$ | Gm. Mol. $C_6H_2OH(NO_2)_3$ per liter | |
|---|---|---|---|
| | | Aqueous phase | $C_6H_6$ phase |
| 1.0023 | 0.0217 | 0.01006 | 0.01982 |
| 1.0274 | 0.2556 | 0.00889 | 0.02122 |
| 1.0469 | 0.426 | 0.00815 | 0.02218 |
| 1.0520 | 0.482 | 0.00797 | 0.02260 |
| 1.0585 | 0.543 | 0.00740 | 0.002245 |
| 1.0822 | 0.765 | 0.00690 | 0.002395 |
| 1.0942 | 0.874 | 0.00615 | 0.002360 |
| 1.1065 | 0.991 | 0.00557 | 0.002450 |

## Distribution of Picric Acid Between Aqueous Solutions of Salts and Benzene at 25°. (Schreiner, 1924.)

### Results for Aq. $BaCl_2 + C_6H_6$.

| Gm. equiv. $BaCl_2$ per liter. | Mols. $OH.C_6H_2(NO_2)_3$ per liter | |
|---|---|---|
| | aq. layer. | $C_6H_6$ layer. |
| 0.015 | 0.0187 | 0.0534 |
| 0.025 | 0.0170 | 0.0419 |
| 0.035 | 0.0179 | 0.0442 |
| 0.050 | 0.0165 | 0.0358 |

### Results for Aq. $NaCl + C_6H_6$.

| Gm. equiv. NaCl per liter | Mols. $OH.C_6H_2(NO_2)_3$ per liter | |
|---|---|---|
| | aq. layer. | $C_6H_6$ layer. |
| 0.015 | 0.0250 | 0.0924 |
| 0.025 | 0.0254 | 0.0924 |
| 0.050 | 0.0240 | 0.0784 |
| 0.100 | 0.0228 | 0.0674 |

### Results for Aq. $MgSO_4 + C_6H_6$.

| Gm. equiv. $MgSO_4$ per liter. | Mols. $OH.C_6H_2(NO_2)_3$ per liter | |
|---|---|---|
| | aq. layer. | $C_6H_6$ layer. |
| 0.015 | 0.0250 | 0.0796 |
| 0.025 | 0.0260 | 0.0772 |
| 0.035 | 0.0249 | 0.0662 |
| 0.050 | 0.0235 | 0.0517 |

| Gm. equiv. $MgSO_4$ per liter. | Mols. $OH.C_6H_2(NO_2)_3$ per liter | |
|---|---|---|
| | aq. layer. | $C_6H_6$ layer. |
| 0.065 | 0.0237 | 0.0503 |
| 0.100 | 0.0252 | 0.0471 |
| 0.200 | 0.0253 | 0.0360 |

## Distribution of Picric Acid Between Water and Toluene at 18°.

(Schilow and Lepin, 1922.)

| Gms. $OH.C_6H_2(NO_2)_3$ per 100 cc. of | |
|---|---|
| aq. layer. | toluene layer. |
| 0.236 | 0.534 |
| 0.352 | 1.132 |
| 0.650 | 3.215 |
| 0.980 | 6.810 |
| 1.220 | 10.500* |

* Excess picric acid present.

## Distribution of Picric Acid Between Benzene and Aqueous Solutions of Sodium Chloride at 30°.

(Kozakewitch and Mikhalkov, 1934.)

The picric acid was determined iodometrically instead of by alkali titration using phenol phthaleine as indicator.

| Conc. of NaCl in aq. phase | Gm. mol. $C_6H_3OH(NO_2)_3$ per liter: Aqueous phase(1) | $C_6H_6$ phase(2) | $\frac{1}{2}$ | Conc. of NaCl in aq. phase | Gm. mol. $C_6H_3OH(NO_2)_3$ per liter: Aqueous phase(1) | $C_6H_6$ phase(2) | $\frac{1}{2}$ |
|---|---|---|---|---|---|---|---|
| 0.0(= $H_2O$) | 0.00323 | 0.00456 | 0.710 | 0.3 normal | 0.01975 | 0.0476 | 0.415 |
| " | 0.00628 | 0.0985 | 0.638 | " | 0.02680 | 0.0827 | 0.324 |
| " | 0.00777 | 0.0125 | 0.617 | " | 0.03300 | 0.1215 | 0.272 |
| " | 0.01350 | 0.0332 | 0.407 | " | 0.03815 | 0.1620 | 0.237 |
| " | 0.01847 | 0.0573 | 0.322 | 0.6 normal | 0.00321 | 0.00428 | 0.759 |
| " | 0.02270 | 0.0840 | 0.270 | " | 0.00787 | 0.01130 | 0.698 |
| " | 0.03327 | 0.1640 | 0.230 | " | 0.01405 | 0.02940 | 0.478 |
| 0.1 normal | 0.00305 | 0.003352 | 0.855 | " | 0.01930 | 0.05125 | 0.377 |
| " | 0.00732 | 0.0105 | 0.773 | " | 0.02427 | 0.07420 | 0.327 |
| " | 0.0133 | 0.0255 | 0.521 | " | 0.02860 | 0.10050 | 0.285 |
| " | 0.0183 | 0.0446 | 0.411 | 1.0 normal | 0.00368 | 0.00497 | 0.742 |
| " | 0.0226 | 0.0668 | 0.338 | " | 0.00487 | 0.00673 | 0.725 |
| " | 0.0273 | 0.0918 | 0.298 | " | 0.00707 | 0.0110 | 0.640 |
| 0.3 normal | 0.00527 | 0.0040 | 1.330 | " | 0.00993 | 0.0193 | 0.515 |
| " | 0.01142 | 0.0161 | 0.712 | " | 0.01205 | 0.0304 | 0.397 |
| | | | | " | 0.01590 | 0.0412 | 0.386 |

## Distribution of Picric Acid Between Water and Gelatin at 15°.

(Cooper and Treadgold, 1934.)

0.5 gm. portions of gelatin were immersed in 40 cc quantities of picric acid solutions of varying concentrations and after standing 3 days at 15° the picric acid remaining in the aqueous phase was determined by titration with alkali.

| Gms. $C_6H_3OH(NO_2)_3$ in aq. phase: Initially | Finally(1) | Gms. $C_6H_3OH(NO_2)_3$ taken up per 1 gm. gelatin(2) | $\frac{2}{1}$ |
|---|---|---|---|
| 0.0006 | 0.0004 | 0.0133 | 33.2 |
| 0.0011 | 0.0004 | 0.0534 | 133.5 |
| 0.0019 | 0.0005 | 0.1069 | 214.0(1) |
| 0.0028 | 0.0009 | 0.1527 | 158.5(1) |
| 0.0056 | 0.0033 | 0.1814 | 55.0(1) |
| 0.0112 | 0.0085 | 0.2154 | 25.3(1) |

(1) In these cases the gelatin precipitated.

## Solubility of Picric Acid in Absolute Alcohol.

(Behrend — Z. physik. Ch. 10, 265, '92.)

100 gms. sat. solution contain 5.53 grams $C_6H_3N_3O_7$ at 12.3°, and 5.92 grams at 14.8°. Sp. Gr. of the latter solution = 0.8255.

100 gms. ethyl alcohol dissolve 8.37 gms. $C_6H_2OH(NO_2)_3$ at 22°. (Timofeiew, 1894.)
100 gms. methyl alcohol dissolve 22.5 gms. $C_6H_2OH(NO_2)_3$ at 22°. "
100 gms. propyl alcohol dissolve 3.81 gms. $C_6H_2OH(NO_2)_3$ at 22°. "
100 gms. 95% formic acid dissolve 10.83 gms. $C_6H_2OH(NO_2)_3$ at 19.8°. (Aschan, 1913.)

## Solubility of Picric Acid in Mixtures of Methyl and Ethyl Alcohols at 25°.

(Duff and Bills, 1931.)

| Gms. $CH_3OH$ per 100 gms. $CH_3OH + C_2H_5OH$ | Gms. $C_6H_2OH(NO_2)_3$ per 100 gms. solvent | Gms. $CH_3OH$ per 100 gms. $CH_3OH + C_2H_5OH$ | Gms. $C_6H_2OH(NO_2)_3$ per 100 gms. solvent |
|---|---|---|---|
| 0 | 8.0 | 60 | 14.9 |
| 20 | 9.8 | 80 | 17.6 |
| 40 | 12.3 | 100 | 21.1 |

## Solubility of Picric Acid in Ether.

(Bougault, 1903.)

| Solvent. | t°. | Gms. $C_6H_3N_3O_7$ per Liter | |
|---|---|---|---|
| Ether of Sp. Gr. 0.721 | 13 | 10.8 | (B.) |
| Ether of Sp. Gr. 0.725 (0.8 pt. $H_2O$ per 100) | 13 | 36.8 | " |
| Ether of Sp. Gr. 0.726 (1 pt. $H_2O$ per 100) | 13 | 40 | " |
| Ether saturated with $H_2O$ | 15 | 51.2 | |
| $H_2O$ saturated with Ether | 15 | 13.8 | |

100 parts of ether dissolve about 2.27 gms. picric acid at 15°. (S. 1905.)
" chloroform " " 2 " " " " "
" petroleum ether " " 0.04 " " " " "
100 gms. sat. solution in pure ether contain 5 gms. picric acid at 20°. (Sisley, 1902.)
100 cc. sat. solution in pure ether contain 3.7 gms. picric acid at 20°. "
100 gms. sat. solution in pure toluene contain 12 gms. picric acid at 20°. "
100 cc. sat. solution in pure toluene contain 10.28 gms. picric acid at 20°. "
100 cc. sat. solution in pure amyl alcohol contain 1.755 gms. picric acid at 20°. "

## Solubility of Picric Acid in Benzene.

(Findlay.)

| t°. | Gms. $C_6H_3N_3O_7$ per 100 Gms. $C_6H_6$. | Mols. $C_6H_3N_3O_7$ per 100 Mols. $C_6H_6$. | t°. | Gms. $C_6H_3N_3O_7$ per 100 Gms. $C_6H_6$. | Mols. $C_6H_3N_3O_7$ per 100 Mols. $C_6H_6$. |
|---|---|---|---|---|---|
| 5 | 3.70 | 1.26 | 38.4 | 26.15 | 8.88 |
| 10 | 5.37 | 1.83 | 45 | 33.57 | 11.40 |
| 15 | 7.29 | 2.48 | 55 | 50.65 | 17.21 |
| 20 | 9.56 | 3.25 | 58.7 | 58.42 | 19.83 |
| 25 | 12.66 | 4.30 | 65 | 71.31 | 24.20 |
| 26.5 | 13.51 | 4.60 | 75 | 96.77 | 32.92 |
| 35 | 21.38 | 7.26 | | | |

The solubility of Picric Acid in Benzene and in Tetralin was determined by Piatti, 1931, but the results are presented only in the form of a small diagram.

100 gms. liquid Sulfur Dioxide dissolve about 38 gms. picric acid.
" " " Ammonia " " 58 " " "
(De Carli, 1927.)

## Solubility of 1.2.4.6 Trinitro Phenol (Picric Acid) in Several Solvents.

(Desvergnes, 1927.)

| Solvent | Gms. $C_6H_3O_7N_3$ per 100 gms. solvent at 16° | Gms. $C_6H_3O_7N_3$ per 100 gms. solvent at 50° | Solvent | Gms. $C_6H_3O_7N_3$ per 100 gms. solvent at 16° | Gms. $C_6H_3O_7N_3$ per 100 gms. solvent at 50° |
|---|---|---|---|---|---|
| $CH_3COOC_2H_5$ | 39.41 | 68.48 | $CHCl_3$ | 2.02 | 5.67 |
| $(CH_3)_2CO$ | 123.23 | 220.53 | $(C_2H_5)_2O$ | 2.64 | 3.96(34°) |
| $CH_3OH$ | 15.95 | 40.25 | $C_5H_5N$ | 27.62 | 58.94 |
| 96% $C_2H_5OH$ | 9.20 | 20.69 | $CS_2$ | 0.11 | 0.18(34°) |
| 100 % " | 6.83 | 19.72 | $CCl_4$ | 0.065 | 0.35 |
| $C_6H_6$ | 7.49 | 29.45 | $C_6H_5CH_3$ | 12.24 | 27.84 |

## Solubility of Picric Acid in Several Solvents.

| Solvent. | t° | Gms. $OH.C_6H_2(NO_2)_3$ per 100 gms. solvent. | Authority. |
|---|---|---|---|
| Carbon tetrachloride..... | 20 | 0.07 | (Pawlewski. 1914, 1926.) |
| Chloroform..... | 20 | 1.86 | » |
| Para Cymene (b. pt. 176°-176°,5... | 25 | 2.611 | (Wheeler, 1920.) |
| Glycol Diacetate (b. pt. 188°-189°,6). | 25 | 46.3 | (Taylor and Rinkenbach, 1926.) |

## Solubility of Picric Acid in Mixtures of Solvents at 12°.

(Angelescu and Dumitrescu, 1923.)

The mixtures of solvents were saturated with picric acid at 25°-30° and then the excess of picric acid was allowed to crystallize out while the solutions were kept in a thermostat at 12°. Thus constant agitation was not employed. The solutions were analyzed by evaporating the solvent at room temperature, dissolving the residue of picric acid and titrating it with 0.1 *n* KOH, using phenolphthalein as indicator.

Results for the Solubility of Picric Acid in Mixtures of :

Carbon Tetrachloride and Ethyl Alcohol.

| Gms. per 100 gms. sat. sol. | | |
|---|---|---|
| $CCl_4$. | $C_2H_5OH$. | $OHC_6H_2(NO_2)_3$. |
| 99.91 | 0.0 | 0.09 |
| 89.81 | 9.02 | 1.17 |
| 83.77 | 14.14 | 2.09 |
| 77 67 | 19.65 | 2.68 |
| 69.73 | 26.95 | 3.32 |
| 64.07 | 32.20 | 3.73 |
| 55.99 | 39.89 | 4.12 |
| 37.59 | 56.87 | 5.54 |
| 15.13 | 77.27 | 7.60 |
| 0.0 | 90.56 | 9.44 |

Chloroform and Ethyl Alcohol.

| Gms. per 100 gms. sat. sol. | | |
|---|---|---|
| $CHCl_3$. | $C_2H_5OH$. | $OHC_6H_2(NO_2)_3$. |
| 98.01 | 0.0 | 1.99 |
| 86.48 | 9.51 | 4.01 |
| 80.57 | 14.60 | 4.83 |
| 74.65 | 20.10 | 5.25 |
| 69.18 | 25.11 | 5.71 |
| 60.54 | 33.40 | 6.06 |
| 52.82 | 41.08 | 6.10 |
| 44.96 | 48.88 | 6.16 |
| 41.99 | 51.52 | 6.49 |
| 25.30 | 68.33 | 6.37 |
| 13.94 | 79.11 | 6.95 |

Benzene and Ethyl Alcohol.

| Gms. per 100 gms. sat. sol. | | |
|---|---|---|
| $C_6H_6$. | $C_2H_5OH$. | $OHC_6H_2(NO_2)_3$. |
| 93.51 | 0.0 | 6.49 |
| 72.64 | 13.98 | 13.38 |
| 65.01 | 19.88 | 15.11 |
| 59.21 | 25.01 | 15.78 |
| 51.18 | 32.54 | 16.28 |
| 57.81 | 46.81 | 15.38 |
| 23.37 | 62.97 | 13.66 |
| 16.14 | 71.84 | 12.02 |
| 8.78 | 81.27 | 9.95 |
| 0.0 | 90.56 | 9.44 |

## Solubility of Picric Acid in Mixtures of Benzene and Hexane.

(Tausz and Schnabel, 1919.)

The temperature is not stated. The picric acid was determined by titration with 0.1 *n* Na OH using phenolphthalein as indicator.

| Solvent | | Cc., 0.1 *n* Na OH per 100 cc. sat. sol. | Gms $OH.C_6H_2(NO_2)_3$ per 100 cc. sat. sol. |
|---|---|---|---|
| cc. $C_6H_6$ + | cc. $C_6H_{14}$. | | |
| 75 | 25 | 152 | 3.474 |
| 50 | 50 | 49 | 1.123 |
| 25 | 75 | 10 | 0.229 |
| 0 | 100 | 0 | 0.0 |

## Solubility of Picric Acid in Mixtures of Carbon Tetra Chloride and:

(Angelescu and Dumitrescu, 1928.)

### Ethyl Alcohol at 12°

| Wt. % $C_2H_5OH$ in solvent | Gms. $C_6H_2OH(NO_2)_3$ per 100 gms. solvent |
|---|---|
| 0.0 | 0.09 |
| 9.12 | 1.18 |
| 14.14 | 2.13 |
| 20.19 | 2.75 |
| 27.87 | 3.43 |
| 33.45 | 3.87 |
| 41.60 | 4.29 |
| 60.20 | 5.86 |
| 83.62 | 8.72 |
| 100.0 | 10.42 |

### Acetone at 12°

| Wt. % $(CH_3)_2CO$ in solvent | Gms. $C_6H_2OH(NO_2)_3$ per 100 gms. solvent |
|---|---|
| 0.0 | 0.09 |
| 4.16 | 1.45 |
| 8.28 | 3.61 |
| 15.02 | 8.37 |
| 20.32 | 11.97 |
| 26.86 | 18.31 |
| 34.28 | 26.50 |
| 41.13 | 34.77 |
| 51.42 | 47.73 |
| 71.90 | 79.53 |
| 80.99 | 90.29 |
| 100.0 | 194.20 |

### Benzene at 12°

| Wt. % $C_6H_6$ in solvent | Gms. $C_6H_2OH(NO_2)_3$ per 100 gms. solvent |
|---|---|
| 0.0 | 0.09 |
| 8.12 | 0.31 |
| 10.47 | 0.40 |
| 15.58 | 0.55 |
| 21.43 | 0.93 |
| 29.08 | 1.57 |
| 34.52 | 2.12 |
| 41.95 | 3.20 |
| 53.31 | 4.78 |
| 73.82 | 6.45 |
| 84.59 | 7.17 |
| 100.0 | 6.94 |

### Benzene at 25°(1)

| Wt. % $C_6H_6$ in solvent | Gms. $C_6H_2OH(NO_2)_3$ per 100 gms. solvent |
|---|---|
| 0.0 | 0.12 |
| 24.9 | 1.14 |
| 48.1 | 3.22 |
| 76.4 | 7.59 |
| 100.0 | 10.71 |

(1) Mathieu, 1936.

In the case of the results of Angelescu and Dumitrescu, the solvent mixtures were saturated with picric acid at 20-25° and the excess allowed to crystallize out while standing at 12°.

## Solubility of Picric Acid in Mixtures of Carbon Disulfide and:

(Mahieu, 1936.)

| Acetone at 25° | | Ethyl Ether at 25° | | Benzene at 25° | |
|---|---|---|---|---|---|
| Wt. % $(CH_3)_2CO$ in solvent | Gms. $C_6H_2OH(NO_2)_3$ per 100 gms. solvent | Wt. % $(C_2H_5)_2O$ in solvent | Gms. $C_6H_2OH(NO_2)_3$ per 100 gms. solvent | Wt. % $C_6H_6$ in solvent | Gms. $C_6H_2OH(NO_2)_3$ per 100 gms. solvent |
| 0.0 | 0.14 | 0.0 | 0.14 | 15.12 | 0.52 |
| 25.4 | 22.4 | 24.1 | 0.68 | 31.1 | 1.21 |
| 50.7 | 71.4 | 46.7 | 2.52 | 38.6 | 1.81 |
| 76.4 | 116.24 | 77.7 | 2.42 | 51.0 | 2.83 |
| 100.0 | 158.6 | 100.0 | 2.39 | 76.7 | 6.31 |
| | | | | 100.0 | 10.71 |

## Solubility of Picric Acid in Mixtures of Chloroform and:

### Ethyl Alcohol at 12°
(Angelescu and Dumitrescu, 1928.)

| Wt. % $C_2H_5OH$ in solvent | Gms. $C_6H_2OH(NO_2)_3$ per 100 gms. solvent |
|---|---|
| 0.0 | 2.03 |
| 9.90 | 4.17 |
| 21.21 | 5.50 |
| 34.42 | 6.42 |
| 44.05 | 6.54 |
| 54.90 | 6.91 |
| 73.07 | 6.81 |
| 84.49 | 7.42 |
| 100.00 | 10.42 |

### Acetone at 12°
(Angelescu and Dumitrescu, 1928.)

| Wt. % $(CH_3)_2CO$ in solvent | Gms. $C_6H_2OH(NO_2)_3$ per 100 gms. solvent |
|---|---|
| 0.0 | 2.03 |
| 3.46 | 5.26 |
| 15.27 | 8.73 |
| 28.43 | 19.65 |
| 45.13 | 42.06 |
| 55.12 | 61.42 |
| 65.51 | 88.86 |
| 73.40 | 132.34 |
| 84.34 | 161.92 |
| 100.00 | 194.20 |

### Acetone at 25°
(Mahieu, 1936.)

| Wt. % $(CH_3)_2CO$ in solvent | Gms. $C_6H_2OH(NO_2)_3$ per 100 gms. solvent |
|---|---|
| 0.0 | 2.23 |
| 27.7 | 18.17 |
| 47.0 | 42.72 |
| 72.3 | 87.46 |
| 100.0 | 158.6 |

### Ethyl Ether at 25°
(Mahieu, 1936.)

| Wt. % $(C_2H_5)_2O$ in solvent | Gms. $C_6H_2OH(NO_2)_3$ per 100 gms. solvent |
|---|---|
| 0.0 | 2.23 |
| 23.9 | 1.20 |
| 49.0 | 1.18 |
| 73.2 | 1.43 |
| 100.0 | 2.39 |

## Solubility of Picric Acid in Mixtures of Methyl Alcohol and Benzene.
(Duff and Bills, 1932.)

| Wt. % $CH_3OH$ in solvent | Gms. $C_6H_2OH(NO_2)_3$ per 100 gms. solvent at | | |
|---|---|---|---|
| | 0° | 12.5° | 25° |
| 0 | — | 5.6 | 10.4 |
| 10 | 10.0 | 14.5 | 28.5 |
| 20 | 13.3 | 21.0 | 42.9 |
| 30 | 15.4 | 26.4 | 46.5 |
| 40 | 17.2 | 29.2 | 46.5 |
| 50 | 18.5 | 29.8 | 44.6 |
| 60 | 19.8 | 29.2 | 40.6 |
| 70 | 20.5 | 26.5 | 36.0 |
| 80 | 18.2 | 23.1 | 30.6 |
| 90 | 16.2 | 19.8 | 25.6 |
| 10 | 13.8 | 16.0 | 21.1 |

## Solubility of Picric Acid in Mixtures of Ethyl Alcohol and Benzene.

(Duff and Bills, 1932.)

| Wt. % $C_2H_5OH$ in solvent | Gms. $C_6H_2OH(NO_2)_3$ per 100 gms. solvent at: | | | | |
|---|---|---|---|---|---|
| | 0° | 12° (1) | 12.5° | 25° | 25° (2) |
| 0 | — | 6.9 | 5.6 | 10.4 | 10.7 |
| 10 | 9.3 | 12.0 | 13.4 | 24.5 | 23.0 |
| 20 | 10.0 | 16.6 | 16.6 | 31.4 | 29.0 |
| 30 | 10.7 | 19.0 | 18.3 | 30.6 | 30.5 |
| 40 | 11.0 | 19.5 | 18.1 | 28.2 | 29.0 |
| 50 | 10.8 | 19.0 | 17.6 | 25.0 | 27.0 |
| 60 | 10.3 | 17.7 | 16.0 | 21.7 | 24.5 |
| 70 | 9.5 | 16.2 | 14.0 | 17.8 | 21.5 |
| 80 | 8.2 | 14.0 | 11.1 | 13.7 | 18.0 |
| 90 | 6.6 | 11.0 | 8.2 | 10.1 | 13.5 |
| 100 | 4.5 | 10.4 | 5.8 | 8.0 | 7.8 |

(1) These results taken from curve plotted from the results of Angelescu and Dumitrescu, 1928.

(2) These results taken from curve plotted from the results of Mahiew, 1936.

## Solubility of Picric Acid in Mixtures of Benzene and:

(Duff and Bills, 1932.)

| Wt. % $C_6H_6$ in solvent in each case | Propyl Alcohol | | Iso Propyl Alcohol | | Butyl Alcohol | |
|---|---|---|---|---|---|---|
| | Gms. $C_6H_2OH(NO_2)_3$ per 100 gms. solvent at | | Gms. $C_6H_2OH(NO_2)_3$ per 100 gms. solvent at | | Gms. $C_6H_2OH(NO_2)_3$ per 100 gms. solvent at | |
| | 0° | 25° | 0° | 25° | 0° | 25° |
| 0 | 2.4 | 3.7 | 5.8 | 8.7 | 1.8 | 2.9 |
| 10 | 3.4 | 5.4 | 6.2 | 9.8 | 2.7 | 4.4 |
| 20 | 4.3 | 7.8 | 6.8 | 11.3 | 3.4 | 6.9 |
| 30 | 5.2 | 11.2 | 7.4 | 13.8 | 4.2 | 9.9 |
| 40 | 6.1 | 14.5 | 8.0 | 17.0 | 5.0 | 12.6 |
| 50 | 6.9 | 17.7 | 8.6 | 20.0 | 5.9 | 15.4 |
| 60 | 7.4 | 20.7 | 8.8 | 22.5 | 6.5 | 17.8 |
| 70 | 7.8 | 23.0 | 8.8 | 25.0 | 6.8 | 19.9 |
| 80 | 7.6 | 25.0 | 8.2 | 25.4 | 6.5 | 21.5 |
| 90 | 6.5 | 21.0 | 6.6 | 22.5 | 5.8 | 19.6 |
| 100 | — | 10.4 | — | 10.4 | — | 10.4 |

## Solubility of Picric Acid in Mixtures of Benzene and:

### Acetone at 12°

(Angelescu and Dumitrescu, 1928.)

| Wt. % $C_6H_6$ in solvent | Gms. $C_6H_2OH(NO_2)_3$ per 100 gms. solvent |
|---|---|
| 0.0 | 194.2 |
| 18.52 | 164.90 |
| 26.89 | 112.58 |
| 44.37 | 87.44 |
| 61.18 | 69.98 |
| 75.65 | 49.89 |
| 85.27 | 34.52 |
| 92.90 | 21.65 |
| 100.0 | 6.94 |

### Ethyl Ether at 12°

(Angelescu and Dumitrescu, 1928.)

| Wt. % $C_6H_6$ in solvent | Gms. $C_6H_2OH(NO_2)_3$ per 100 gms. solvent |
|---|---|
| 0.0 | 3.42 |
| 11.54 | 7.76 |
| 22.03 | 10.14 |
| 37.16 | 12.30 |
| 62.96 | 14.43 |
| 79.00 | 14.50 |
| 88.68 | 12.88 |
| 93.24 | 11.12 |
| 100.0 | 6.94 |

Freezing-point data are given for mixtures of **Picric Acid** and each of the following compounds:

Acetic acid(3)
Acenaphthene(7)
Aceto phenone(2)(10)
Aniline o bromo(18)
Anthracene(21)(35)(48)
Azo benzene(41)
Benzo hydrol(32)(48)
Benzo phenone(34)(10)
α Benzyl naphthalene(7)
Bromo aniline(18)
Chloro " (18)
α and β Bromo naphthalene(7)
Bromo naphthylamine(41)
Camphor(5)
Catechol(25)
Carbazole(13)
and β Chloro naphthalene(7)
Cinnamic acid(31)
o, m, and p Cresol(3)
Di benzyl(7)(8)
1.2.4 Dichloro aniline(18)
1.2.4 Dibromo " (18)
Diethyl diphenyl urea(38)
Dinitro benzenes(36)
" naphthalenes(37)
" toluenes(36)
Diphenyl(8)
Diphenyl amine(9)(20)
Diphenyl methane(7)(14)
Dimethyl oxalate(31)
Dimethyl pyrone(24)
Erithritol(43)
Ethoxy benzal acetophenone(2)
Ethylene bromide + naphthalene(16)
Fenchon(28)
Hydro quinone dimethyl ether(44)
β Methyl naphthoate(4)
Fluorene(48)
Guaiacol(25)
Nitroso di methyl aniline(48)(50)
Methylene dioxy benzal aceto phenone(1)
Methylene dioxy chalcone(2)
" " " + β naphthol(2)
β Naphthol(2)(3)
" " methyl ether(44)
Naphthalene(11)(17)(21)(27)(45)
β Naphthyl acetate(4)
Nitro acenaphthene(7)
Nitro benzene(29)
α Nitro naphthalene(4)(7)
β " " (4)
o,m,p Nitro phenol(6)
Oxy benzaldehyde(21)(42)
Oxy benzal aceto phenone(1)
Phenanthrene(7)
Phenol(11)(21)(22)
Picramide(7)
Picryl chloride(7)(46)
Quinone(29)
Resorcinol(25)
Retene(7)
Salicylaldehyde(30)
Stilbene(7)
Styph nic acid(47)
Succinic acid(31)
Succinimide(28)
Tetryl(32)
Thymol(3)
Tri bromo aniline(18)
Tri nitro m cresol(19)(39)
2.4 di nitro toluene(33)
Tri nitro toluene(32)
α Tri nitro toluene(26)(36)
Tri phenyl carbinol(12)
Tri phenyl methane(7)(15)(23)
Tri nitro phenyl methyl nitramine(40)
Toluic acid(3)

(1) Asahina, 1934; (2) Asahina, 1934a; (3) Kendall, 1916; (4) Shinomiya, 1940; (5) Kremann and Odelga, 1912; (6) Kremann and Rodinis, 1906; (7) Efremov, 1918; (8) Efremov, 1919, 1919a; (9) Kremann and Schadinger, 1919; (10) Kremann and Marktl, 1920; (11) Kremann, 1904,1905; (12) Kremann, Hohl and Müller II, 1921; (13) Kremann and Slovak, 1920; (14) Kremann and Fritsch, 1920; (15) Kremann, Odelga and Zawadosky, 1921; (16) Bruni, 1898; (17) de Gee, 1916; (18) Hertel, 1924; (19) Quist, 1924; (20) Giua and Cherchi, 1919; (21) Rheinboldt, Henning and Kircheisen, 1925; (22) Philip, 1903; (23) Rheinboldt and Kirscheisen, 1926; (24) Kendall, 1914; (25) Philip and Smith, 1905; (26) Giua, 1916; (27) Saposchinikow, 1904; (28) Kremann and Dietrich, 1923; (29 Kremann, Sutter, Sitte, Strzelba and Dobotsky, 1922; (30) Kremann and Zechner, 1925; (31) Kremann, Zechner and Drazil, 1924; (32) Taylor and Rinkenbach, 1923a; (33) Wogrinz and Vari, 1919; (34) Puschin and Rikovski, 1930; (35) Milone and Rossingnoli, 1932; (36) Hrynakowski and Kapuscuski, 1933b; (37) Urbanski and Kwistkowski, 1934; (38) Giua and Guastalla, 1933; (39) Jefremow and Tichomirowa, 1927; (40) Jefremow and Trichomirowa, 1926; (41) Kremann, Zechner and Weber, 1924; (42) Kremann and Pogantsch, 1923; (43) Puschin and Dezelic, 1932; (44) Giua and Marcellino, 1920; (45) Milone and Rossingoli, 1932; (46) Grimm, Günther and Titus, 1931; (47) Jefremow, 1934: (48) Kremann and Drazil, 1924.(48) Kremann, 1911 (48) Kremann and Wlk. 1919.

### Solubility of Picric Acid in Mixtures of:

**Acetone and Nitrobenzene at 25°** (Mahieu, 1936.)

| Wt. % $(CH_3)_2CO$ in solvent | Gms. $C_6H_2OH(NO_2)_3$ per 100 gms. solvent |
|---|---|
| 0.0 | 39.1 |
| 24.9 | 68.3 |
| 47.5 | 97.7 |
| 74.5 | 118.1 |
| 100.0 | 158.6 |

**Ethyl Ether and Ethyl Alcohol**

| Wt. % $C_2H_5OH$ in solvent | Gms. $C_6H_2OH(NO_2)_3$ per 100 gms. solvent |
|---|---|
| 0.0 | 3.42 |
| 9.50 | 8.60 |
| 26.90 | 12.38 |
| 60.86 | 14.15 |
| 74.69 | 13.18 |
| 84.65 | 11.49 |
| 100.00 | 10.42 |

### Solubility of Picric Acid in Mixtures of Benzene and:

**Acetone at 25°** (Mahieu, 1936.)

| Wt. % $C_6H_6$ in solvent | Gms. $C_6H_2OH(NO_2)_3$ per 100 gms. solvent |
|---|---|
| 0.0 | 158.6 |
| 10.9 | 127.5 |
| 23.7 | 117.8 |
| 49.7 | 99.7 |
| 74.5 | 62.3 |
| 100 | 10.7 |

**Toluene at 25°** (Mahieu, 1936.)

| Wt. % $C_6H_6$ in solvent | Gms. $C_6H_2OH(NO_2)_3$ per 100 gms. solvent |
|---|---|
| 0 | 13.16 |
| 29.7 | 13.49 |
| 53.1 | 13.5 |
| 74.0 | 13.39 |
| 100.0 | 10.71 |

## Trinitro **RESORCINOL** $(NO_2)_3C_6H(OH)_2$

100 gms. glycol diacetate dissolve about 13.0 gms. trinitro resorcinol at 20-25°. (Taylor and Rinkenbach, 1926.)

## Tetra Nitr**ANILINE** 1.2.3.5 $(NO_2)_4C_6H\ NH_2$.

Solubility in Several Solvents at 0°. (Taylor and Rinkenbach. 1926.)

| Solvent. | Gms. $(NO_2)_4\ C_6H\ NH_2$ per 100 gms. solvent. |
|---|---|
| Water | 0.007 |
| Methyl alcohol | 0 45 |
| Ethyl alcohol | 0.34 |
| Ethyl ether | 0.081 |
| Acetone | 7.50 |
| Chloroform | 0.010 |
| Carbon tetrachloride | 0.0036 |
| Carbon bisulfide | 0.0056 |
| Benzene (3°.9) | 0.13 |
| Toluene | 0.188 |

## **STYPHNIC ACID** (2.4.6 Trinitro Resorcinol) $C_6H(OH)_2(NO_2)_3$.

Solubility of Styphnic Acid in Aqueous Solutions of Hydrochloric Acid and of Nitric Acid at 25°. (Knox and Richards, 1919.)

In aq. Hydrochloric acid.

| Equiv. Normality. HCl. | Equiv. Normality. $C_6H(OH)_2(NO_2)_3$. |
|---|---|
| 0.00 | 0.02179 |
| 1.410 | 0.00062 |
| 2.814 | 0.00060 |
| 4.221 | 0.00072 |
| 5.634 | 0.00093 |
| 6.997 | 0.00163 |
| 8 418 | 0.00197 |
| 11.10 | 0.00397 |
| 11.16 | 0.00387 |

In aq. Nitric acid.

| Equiv. Normality. $HNO_3$. | Equiv. Normality. $C_6H(OH)_2(NO_2)_3$. |
|---|---|
| 0.00 | 0.02179 |
| 1.785 | 0.001403 |
| 4.171 | 0.002180 |
| 6.234 | 0.003271 |
| **8.368** | 0.005108 |
| 10.31 | 0.007944 |
| 11.97 | ..01298 |
| 13.97 | 0.02742 |
| 15.57 | 0.05611 |

Freezing-point data are given by Jefremow, 1918, 1919a, 1927, 1934, for mixtures of Styphnic acid and:

| | | |
|---|---|---|
| Acenaphthene | Hydroquinone | Phenanthrene |
| Benzyl naphthalene | Naphthalene | Resorcinol |
| Bi benzyl | Naphthols | Retene |
| Bi phenyl | Nitro acenaphthene | Stilbene |
| " " methane | Nitro anilines | Tri nitro benzene |
| Bromo naphthalene | Nitro pyrocatechols | " " toluene |
| Chloro " | Nitro naphthalene | " " xylene |
| Di nitro resorcinols | Nitro hydroquinone | " chloro phenol |
| " " phenol | Nitro phenols | " nitro phenol |
| Fluorene | Nitro resorcinols | " " cresol |

Results for mixtures of styphnic acid + anthracene are given by Kremann & Müller II, 1921, for mixtures with tri nitro phenyl methyl nitr amine by Jefremow and Tichomirowa, 1926; and for mixtures with tri chloro phenol by Janecke and Rahlfs, 1932.

## TRI NITRO PHLOROGLUCINOL $C_6(OH)_3(NO_2)_3$.

Freezing-point data for mixtures of Tri nitro phloro glucinol and Tri nitro resorcinol. (Hertel and Schneider, 1931.)

## DiBromo**BENZENE** (*p*) $C_6H_4Br_2$.

### Solubility in Ethyl, Propyl, Iso Butyl Alcohols, etc.

(Schröder — Z. physik. Chem. 11, 456, '93.)

Determinations by "Synthetic Method" see Note, p. 292.

| t°. | Grams $C_6H_4Br_2$ (*p*) per 100 Grams Sat. Solution in: | | | | | | |
|---|---|---|---|---|---|---|---|
| | $C_2H_5OH$. | $C_3H_7OH$. | $(CH_3)CH.CH_2OH$. | $(C_2H_5)_2O$. | $CS_2$. | $C_6H_6$. | $C_6H_5Br$. |
| 0 | ... | .. | ... | .. | 27 | .. | .. |
| 10 | ... | .. | ... | 30 | 34 | 34 | 22 |
| 20 | ... | .. | ... | 38 | 43 | 43 | 29 |
| 30 | 14 | .. | 15 | 47 | 53 | 53 | 36 |
| 40 | 19 | .. | 20 | 57 | 62 | 62 | 45 |
| 50 | 26 | 27 | 30 | 67 | 72 | 71 | 54 |
| 60 | 38 | 40 | 44 | 77 | 81 | 80 | 67 |
| 70 | 57 6 | 67 | 65 | 87 | 90 | 88 | 79 |
| 75 | 80.5 | 85 | 77 | .. | .. | .. | 84 |
| 80 | 94.4 | 95 | 94.6 | .. | .. | .. | 90 |

### Solubility of Mixtures of *p* Dibromobenzene and *p* Dichlorobenzene in Aqueous Solutions of Ethyl Alcohol

Solvent, 50 Vol. % $C_2H_5OH$, $t = 49.1°$.
(Küster and Dahmer, 1905.)

| Gms. per 100 cc. Sat. Sol. | | Mol. % $C_6H_4Br_2$ in Solute. |
|---|---|---|
| $C_6H_4Br_2$. | $C_6H_4Cl_2$. | |
| 0.484 | 0 | 100 |
| 0.505 | 0.044 | 89.8 |
| 0.496 | 0.084 | 80.7 |
| 0.477 | 0.503 | 59.3 |
| 0.470 | 0.721 | 54.4 |
| 0.196 | 1.311 | 11.6 |
| 0 | 1.614 | 0 |

Solvent, 90.9 Vol. % $C_2H_5OH$, $t = 25°$
(Küster and Würfel, 1904–05.)

| Gms. per 100 cc. Sat Sol. | | Mol. % $C_6H_4Br_2$ in Solute. |
|---|---|---|
| $C_6H_4Br_2$. | $C_6H_4Cl_2$. | |
| 2.909 | 0 | 100 |
| 2.674 | 0.696 | 94.3 |
| 2.220 | 2.808 | 70.7 |
| 1.769 | 4.249 | 49.1 |
| 1.271 | 6.237 | 24.5 |
| 0.675 | 6.877 | 9.9 |
| 0 | 8.271 | 0 |

Additional data for the above system are given by Thiel (1903).

SOLUBILITY OF *p* DIBROMOBENZENE IN SEVERAL SOLVENTS AT 25°.
(Hildebrand, Ellefson and Beebe, 1917.)

| Solvent. | Gms. $C_6H_4Br_2$ (*p*) per 100 Gms. Solvent | Solvent. | Gms. $C_6H_4Br_2$ (*p*) per 100 Gms. Solvent. |
|---|---|---|---|
| Methyl Alcohol | 10.35 | Carbon Tetrachloride | 36.6 |
| Benzene | 83.8 | Ethyl Ether | 71.3 |
| Carbon Disulfide | 90 | Hexane | 25.9 |

Di Bromo **BENZENE** (Para) $C_6H_4Br_2$.

SOLUBILITY OF DIBROMOBENZENE IN SEVERAL SOLVENTS. (Mortimer, 1923.)

| | Mols. *p* $C_6H_4Br_2$ per 100 mols. saturated solution in : | | | | | |
|---|---|---|---|---|---|---|
| t°. | $C_6H_6$. | $C_6H_5CH_3$. | $CCl_4$. | $C_6H_5NO_2$. | $C_6H_5NH_2$. | $C_6H_5OH$. |
| 0..... | 11.0 | 10.5 | 7.9 | 6.9 | 3.3 | – |
| 20..... | 20.2 | 19.7 | 15.9 | 14.4 | 8.5 | – |
| 40..... | 34.9 | 34.3 | 29.8 | 27.9 | 19.7 | 1.7 |
| 60..... | 55.7 | 55.1 | 51.1 | 49.1 | 39.6 | 28.6 |
| 80..... | 84.5 | 84.0 | – | 81.1 | 77.6 | 72.0 |

100 gms. methyl formate dissolve 28.4 gms. *p* $C_6H_4Br_2$ at 25°. (Kröber, 1919.)

The critical solution temperature of mixtures of p dibrombenzene and phenyl carbinol is at about 48°. That for mixtures of p dibrom benzene and methyl salicylate, is 69°, for mixtures of p dibrom benzene and n phenyl ethanol is 67°, and for mixtures of p dibrom benzene and menthol is 55°. (Lecat, 1928.)

Freezing-point data are given for mixtures of:

o., m and p Dibromo benzenes. (Holleman and Van der Linden, 1911; Wibaut, van der Lande and Wallagh, 1933.)
Dibrom o benzenes + Dichloro benzenes (Deffet, 1928.)
" " + Nitrobenzene + allyl mustard oil (Schischokim, 1930.)
" " + Bromo iodo benzene (Nagornow, 1911.)
" " + Bromo chloro benzene (Bruni and Gorni, 1899, 1900.)
" " + Bromo toluene (Borodowski and Bogojowlenski, 1904.)
" " + Camphor (Jefremow, 1915.)
" " + p Chloro nitro benzene (Pawlewski, 1898.)
" " + p Di chloro benzene (Bruni and Gorni, 1899, 1900; Küster and Würfel, 1904-5; and Kruyt, 1912.)
" " + Di Chloro benzene + $C_2H_5OH$ (Meyer, 1922, Smits, 1920.)
" " + p Di iodo benzene (Nagornow, 1911.)

**BROMO CHLORO BENZENES** o, m and p $C_6H_4BrCl$.

Freezing-point data are given for mixtures of:

o, m and p Bromochloro benzenes (Holleman and Van der Linden, 1911; Van Loon and Wibaut, 1937.)
Bromo chloro benzenes + p Dibromo benzene (Holleman and Van der Linden, 1911.)
" " " + p Dichloro benzene (Bruni and Gorni, 1899; Kruyt, 1912.)

**BROMO FLUORO BENZENE** $C_6H_4BrF$.

Freezing-point data for mixtures of o, m and p Bromo Fluoro Benzenes are given by Van Loon and Wibaut, 1937.

**BROMO IODO BENZENE** $C_6H_4BrI$.

Freezing-point data for mixtures of:

Bromo Iodo Benzene + Dibromo benzene (Nagornow, 1911.)
" " " + Di iodo benzene (Nagornow, 1911; Rheinboldt and Kircheisen, 1926.)

**DI IODO BENZENE** $C_6H_4I_2$.

Freezing-point data for mixtures of:

Di iodo benzene + Bromo iodo benzene (Nagornow, 1911; Rheinboldt and Kircheisen, 1926.)
" " " + Chloro iodo benzene (Nagornow, 1911.)

**TRI BROMO ANILINE** $C_6H_2Br_3NH_2$.

Freezing-point data are given for mixtures of s tri bromo aniline and 2 chloro 4.6, di bromo aniline. (Sudborough and Lakhamalani, 1917.)

**DICHLORO BENZENES** o, m and p. $C_6H_4Cl_2$.

SOLUBILITY OF o, m, AND p DICHLORO BENZENES, EACH SEPARATELY, IN WATER.
(Klemenc and Low, 1930.)

The method of Rex, 1906, modified by increasing the size of the flask to about 1 liter was used.

| t° | Gms. $C_6H_4Cl_2$ per 1000 gms. $H_2O$ | | |
|---|---|---|---|
| | o compound | m compound | p compound |
| 20 | 0.134 | 0.111 | 0.0689 |
| 25 | 0.145 | 0.123 | 0.0791 |
| 30 | 0.171 | 0.140 | 0.0933 |
| 35 | 0.183 | 0.150 | (0.1044)-(0.0830) |
| 40 | 0.194 | 0.167 | — 0.1008 |
| 45 | 0.203 | 0.177 | 0.1219 |
| 55 | 0.223 | 0.196 | 0.156(1) |
| 60 | 0.232 | 0.201 | 0.163(1) |

(1) liquid state.

The p compound has a transition point from stable to unstable form at 35°. 100 gms. $H_2O$ dissolve 0.077 p $C_6H_4Cl_2$ at 30°. (Gross and Saylor, 1931.)

SOLUBILITY OF p DICHLORO BENZENE IN LIQUID CARBON DIOXIDE.
(Büchner, 1905-06.)

| t° | Gms. p $C_6H_4Cl_2$ per 100 gms. sat. sol. |
|---|---|
| -33 | 1.2 |
| -10 | 4.2 |
| +10 | 11.4 |
| 20 | 22.7 |
| 22 | 34.4 |

The critical solution temperature of mixtures of p dichloro benzene and aniline is 45.5°. (Lecat, 1928.)

Freezing-point data for mixtures of o, m and p Dichloro benzenes are given by Holleman & Van der Linden, 1911; Wibaut, Van der Linden and Walagh, 1937.)

Results for mixtures of Dichloro benzenes and:

Bromo benzene (Timmermans, 1934.)
Bromo chloro benzene (Bruni and Gorni, 1899.)
Chloro benzene (Timmermans, 1934.)
Chloro iodo benzene (Nagornow, 1911.)
Chloro phenol (Burnham and Madgin, 1936.)
Di bromo benzenes (Bruni and Gorni, 1899,1900; Küster and Würfel, 1904-5; Kruyt, 1912; Deffet, 1938.)
Di bromo benzenes + $C_2H_5OH$ (Meyer, 1922; Smits, 1920.)
Di chloro benzene (Timmermans, 1934.)
Di iodo benzene (Nagornow, 1911.)
Di phenyl (Morris and Cook, 1935.)
Fluoro benzene (Timmermans, 1934.)
Naphthalene (Morris and Cook, 1935.)
Nitro benzene (Hrynakowski and Szymt, 1938a.)
o Chloro toluene (Timmermans, 1934.)
o Cresol (Glass and Madgin, 1934.)
p Toluidine (Glass and Madgin, 1934.)
Tetra chloro benzene (Timmermans, 1934.)
Tri phenyl methane (Morris and Cook, 1935.)

**CHLORO IODO BENZENE** p $C_6H_4ClI$.

Freezing-point data are given for mixtures of:

Chloro iodo benzene + di iodo benzene (Nagornow, 1911; Rheinboldt and Kirscheisin, 1926.)
Chloro iodo benzene + di chloro benzene (Nagornow, 1911.)
Di iodo benzene + bromo iodo benzene (Rheinboldt and Kirscheisin, 1926.

**TRI BROMO ANILINE** $C_6H_2NH_2(2.4.6.).Br_3$.

Freezing-point data for mixtures of tri bromo aniline and tri nitro phenol are given by Hertel, 1924.

**BROMO NITROSO BENZENE** $C_6H_4BrNO$.

Freezing-point data are given for mixtures of:

Bromo nitroso benzene + Nitroso anisole (Hammick, Edwards, Illingsworth and Snell, 1933.)
" " " m Nitro nitroso benzene "

**QUINONE** $CO<(CH.CH)_2>CO$.

100 cc. sat. sol. of Quinone in water contain 1.37 gm. $CO<(CH.CH)_2>CO$ at 25°
" " " 0.1 *n* HCl " 1.38 " " "
" " " 1.0 *n* HCl " 1.44 " " "
(Granger and Nelson, 1921.)

The solubility of Quinone in Water at 25°, determined by interferometer readings, is 1.51 gms. $C_6H_4O_2$ per 100 cc $H_2O$. The solubility in 99.8% $D_2O$ (heavy water) is exactly the same. (Korman and LaMer, 1936.)

### Solubility of Quinone in Aqueous 0.01 *n* Hydrochloric Acid.

(Linderström-Lang, 1924; at 23°.75 Kruyt and Robinson, 1926.)

| t°. | Gm. mols. $CO<(CH:CH)_2>CO$ per liter sat. sol. | Gms. $CO<(CH.CH)_2>CO$ per 100 cc. sat. sol. |
|---|---|---|
| 11.85 | 0.0863 | 0.9333 |
| 18.0 | 0.1033 | 1.117 |
| 23.8 | 0.1236 | 1.337 |
| 23.75 | 0.1293 | 1.397 |

### Solubility of Quinone in Aqueous Salt Solutions.

(Linderström-Lang, 1924.)

On account of the instability of quinone at lower concentrations of hydrogen ions the aqueous salt solutions were made in 0.01 *n* H Cl instead of pure water. The results, therefore, show, in all cases, the solubility of quinone in aqueous solutions containing both H Cl present in 0.01 *n* concentration, and the several salts present in the concentrations shown in the table. Constant rotation in a thermostat for 3 to 5 hours was employed. The quinone was prepared by distilling a raw quinone with water vapor. The titrations were made according to Knecht and Hibbert (*Ber.*, 43, 3455, 1910), with titanium chloride in acid solution, and retitration with iron alum, using potassium sulfocyanate as indicator.

| Salt. | t°. | Gm. equiv. salt per liter. | Gm. mol. $CO<(CH.CH)_2>CO$ per liter. |
|---|---|---|---|
| LiCl... | 11.85 | 0.835 | 0.0744 |
| » ... | » | 1.670 | 0.0661 |
| » ... | » | 2.505 | 0.0604 |
| » ... | » | 3.340 | 0.0558 |
| » ... | 18.0 | 0.669 | 0.0908 |
| » ... | » | 1.338 | 0.0818 |
| » ... | » | 2.676 | 0.0692 |
| » .. | » | 4.013 | 0.0625 |
| » ... | » | 5.351 | 0.0593 |
| » ... | 23.5 | 0.835 | 0.1045 |
| » ... | » | 1.670 | 0.0922 |
| » ... | » | 2.505 | 0.0830 |
| » ... | » | 3.340 | 0.0760 |
| NaCl... | 18.85 | 0.4 | 0.0816 |
| » ... | » | 0.8 | 0.0781 |
| » ... | » | 1.6 | 0.0718 |
| » ... | » | 3.2 | 0.0620 |
| » ... | 18.0 | 0.49 | 0.0961 |
| » ... | » | 0.99 | 0.0905 |
| » ... | » | 1.99 | 0.0804 |
| » ... | » | 2.99 | 0.0726 |
| » ... | » | 3.99 | 0.0661 |
| » ... | 23.85 | 0.4 | 0.1152 |
| » ... | » | 0.8 | 0.1092 |
| » ... | » | 1.6 | 0.0974 |
| » ... | » | 3.2 | 0.0821 |
| KSCN. | » | 1.5 | 0.2200* |
| $KNO_3$.. | » | 1.5 | 0.1708* |
| $K_2SO_4$. | » | 3.0 | 0.0824* |
| KCl ... | 11.85 | 0.7 | 0.0839 |
| » ... | » | 1.4 | 0.0826 |
| » ... | » | 2.1 | 0.0808 |
| » ... | » | 2.8 | 0.0792 |
| » ... | 18.0* | 0.7 | 0.0987 |
| » ... | » | 1.4 | 0.0956 |
| » ... | » | 2.1 | 0.0928 |
| » ... | » | 2.8 | 0.0894 |
| KCl ..... | 23.85 | 0.7 | 0.1167 |
| » ..... | » | 1.4 | 0.1119 |
| » ..... | » | 1.5 | 0.1169* |
| » ..... | » | 2.1 | 0.1073 |
| » ..... | » | 2.8 | 0.1026 |
| RbCl.... | 18.0 | 0.6 | 0.1006 |
| » .... | » | 1.2 | 0.0979 |
| » .... | » | 2.4 | 0.0941 |
| CsCl.... | 18 | 0.578 | 0.1016 |
| » .... | » | 0.867 | 0.1019 |
| » .... | » | 1.733 | 0.1002 |
| KBr..... | 17.85 | 0.6 | 0.1086 |
| » ..... | » | 1.2 | 0.1152 |
| » ..... | » | 1.95 | 0.1227 |
| » ..... | 23.75 | 0.6 | 0.1277 |
| » ..... | » | 1.2 | 0.1342 |
| » ..... | » | 1.95 | 0.1408 |
| » ..... | » | 1.5 | 0.1402* |
| KI..... | » | 1.5 | 0.1933* |
| $CaCl_2$ ... | 17.85 | 0.598 | 0.0938 |
| » ... | » | 1.195 | 0.0872 |
| » ... | » | 2.390 | 0.0777 |
| » ... | 23.75 | 0.598 | 0.1112 |
| » ... | » | 1.195 | 0.1026 |
| » ... | « | 2.390 | 0.0903 |
| » ... | » | 3.585 | 0.0819 |
| $Na_2SO_4$.. | 17.85 | 0.36 | 0.0876 |
| » .. | » | 0.72 | 0.0754 |
| » .. | » | 1.44 | 0.0551 |
| » .. | 23.75 | 0.36 | 0.1041 |
| » .. | » | 0.72 | 0.0897 |
| » .. | » | 1.44 | 0.0657 |
| $MgSO_4$.. | 18 | 1.0 | 0.0693 |
| » .. | » | 2.0 | 0.0458 |
| » .. | » | 3.0 | 0.0294 |
| $BaCl_2$ ... | 18 | 1.5 | 0.0883 |
| HCl ..... | » | 1.49 | 0.1139 |
| $H_2SO_4$... | » | 1.49 | 0.0944 |

* Kruyt and Robinson, 1926.

SOLUBILITY OF QUINONE IN AQUEOUS SALT SOLUTIONS AT 17.9°.
(Linderström-Lang, 1929.)

| Salt | Gm. Mol. Salt per liter | Gm. Mol. $C_6H_4O_2$ per liter | Salt | Gm. Mol. Salt per liter | Gm. Mol. $C_6H_4O_2$ per liter |
|---|---|---|---|---|---|
| KI | 0.0 | 0.1030 | $C_2H_5NH_2.HCl$ | 0.747 | 0.0945 |
| " | 0.6 | 0.1231 | " | 1.493 | 0.0889 |
| " | 1.2 | 0.1460 | " | 2.986 | 0.0808 |
| $NH_4Cl$ | 0.8 | 0.0954 | $C_4H_9NH_2.HCl$ | 0.690 | 0.1006 |
| " | 1.6 | 0.0916 | " | 1.390 | 0.0989 |
| " | 3.2 | 0.0864 | $(CH_3)_3(C_2H_5).NCl$ | 0.455 | 0.0981 |
| $CH_3NH_2.HCl$ | 0.666 | 0.0968 | $(C_2H_5)_4NCl$ | 0.705 | 0.0930 |
| " | 1.332 | 0.0929 | " | 1.410 | 0.0793 |
| " | 2.663 | 0.0859 | | | |

Freezing-point data are given by Kremann, Sutter, Sitte, Strzelba and Dobolzky, 1922, for mixtures of Quinone and:

| | | | |
|---|---|---|---|
| Acenaphthene | Hydroquinone | Phenol | Tri nitro phenol |
| Anthracene | Naphthols | Picric Acid | Tri phenyl carbinol |
| Carbazole | Naphthalene | Pyrocatechol | Tri phenyl methane |
| Di nitro phenol | Naphthylamines | Pyrogallol | |
| Di phenylamine | Nitro benzene | Resorcinol | |
| Fluorene | Nitro phenols | Toluidine | |
| | Paraquinone | Tri chlor acetic acid(1) | |

(1) Kendall and Gibbons, 1915.

**BROMO NITRO BENZENES** o, m and p $C_6H_4BrNO_2$.

Freezing-points of mixtures of o, m and p bromo nitro benzenes are given by Holleman and de Bruyn, 1900; Narbutt, 1905. Results for mixtures of Bromo nitro benzenes and:

Chloro nitro benzenes (Kremann, 1908; Kremann and Ehrlich, 1908; Isaac, 1908; Küster, 1891; Hasselblatt, 1913; Kitran, 1924; Puschin, 1926; Puschin and Kitran, 1926; Grimm, Günther and Titus, 1931.
Fluoro nitro benzene (Hasselblatt, 1913.)
Iodo nitro benzene " "
Benzene (Bugojawlewsky, Winogradow and Bogobubow, 1906.)
Cinnamylidene aceto phenone (Giua, 1925.)
Nitro toluene (Grimm, Günther and Titus, 1931.)

**CHLORO NITRO BENZENES** o, m and p $C_6H_4ClNO_2$.

100 gms. $H_2O$ dissolve 0.654 gm. m $C_6H_4ClNO_2$ at 30°. (Gross and Saylor, 1931.)

SOLUBILITY OF p CHLORO NITRO BENZENE IN WATER AND ORGANIC SOLVENTS.
(Desvergnes, 1925.)

| Solvent | Gms. $C_6H_4ClNO_2$(1,4) per 100 gms. solvent at 17° | 50° | Solvent | Gms. $C_6H_4ClNO_2$(1.4) per 100 gms. solvent at 17° | 50° |
|---|---|---|---|---|---|
| Water | 0.0028 | 0.0125 | $CHCl_3$ | 73.62 | 165.75 |
| " | — | 0.0153(100°) | $C_5H_5N$ | 97.62 | 312.67 |
| $CH_3COOC_2H_5$ | 75.67 | 244.59 | $CCl_4$ | 17.42 | 99.11 |
| $(CH_3)_2CO$ | 127.52 | 315.78 | $C_6H_5CH_3$ | 77.59 | 224.59 |
| 96% $C_2H_5OH$ | 6.99 | 30.19 | $CS_2$ | 28.50 | 69.84(33.5°) |
| 100% " | 10.48 | 33.66 | $(C_2H_5)_2O$ | 52.22(15°) | 73.19(32°) |
| $CH_3OH$ | 8.72 | 28.18 | | | |
| $C_6H_6$ | 83.59 | 247.37 | | | |

### Solubility of o and of m Chloro Nitro Benzene, Each Separately, in Liquid Carbon Dioxide.

(Büchner, 1905-06.)

Results for:

| o Chloro Nitro Benzene | | m Chloro Nitro Benzene | |
|---|---|---|---|
| t° | Gms. o $C_6H_4ClNO_2$ per 100 gms. sat. solution | t° | Gms. m $C_6H_4ClNO_2$ per 100 gms. sat. solution |
| -32 | 1.0 | -1 | 1.8 |
| + 5 | 7.8 | +16.5 | 11.2 |
| 7 | 16.5 - 36.0 Quad. pt. | 7.5 | 38.2 Quad. pt. |
| 8 | 58.8 | 20 | 53.2 |
| 11 | 65.8 | | |

100 gms. sat. solution of p chloro nitro benzene in liquid sulfur dioxide contain 38 gms. p $C_6H_4ClNO_2$ at (?) t°. (De Carli, 1927.)

The critical solution temperature of mixtures of p chloro nitro benzene and benzoic acid is 86°. (Lecat, 1929.)

### Solubility of *o*, *m* and *p* Chloronitrobenzenes in Aniline, Determined by the Freezing-point Method.

(Kremann, 1907.)

| t°. | Gms. Each Compound (Determined Separately) per 100 Gms. Sat. Sol. | | |
|---|---|---|---|
| | *o* $C_6H_4ClNO_2$. | *m* $C_6H_4ClNO_2$. | *p* $C_6H_4ClNO_2$. |
| −10 | 43.19 (=31 Mol. %) | 21.60 (=14 Mol. %) | 27.75 (=18.5 Mol. %) |
| − 2.5 | 51.30 (=39 " | 31.67 (=21.5 " | 31.67 (=21.5 " |
| +10 | 69.15 (=57 " | 49.29 (=36.5 " | 38.50 (=27 " |

Freezing-point data for mixtures of o, m and p chloro nitro benzenes are given by Holleman and de Bruyn, 1900; Bogojawlewsky, Winogradow and Bogobubow, 1906; Kohman, 1925.

Results for mixtures of chloro nitro benzenes and:

Aniline (Kremann, 1907; Kremann and Rodinis, 1906.)
Benzene (Bogojawlewski, Winogradow and Bogobubow, 1906.)
Bromo nitro benzenes (Kremann and Ehrlich, 1908; Kitran, 1924; Puchin, 1926.)
Camphor (Jefremow, 1916.)
Cinnamylidine acetophenone (Giua, 1925.)
Di bromo benzenes (Pawlewski, 1898.)
Di phenyl amine (Tinkler, 1913.)
Fluoro nitro benzene (Hasselblatt, 1913.)
Iodo nitro benzene " "
Naphthalene (Kremann and Rodenis, 1906.)
Nitro aniline (Grimm, Gunther and Titus, 1931.)
Nitro bromo benzene (Grimm, Gunther and Titus, 1931.)
Nitro mannite (Urbanski, 1933, 1934.)
Nitro phenol (Grimm, Gunther and Titus, 1931.)
Nitro toluene " " " "

## FLUORO NITRO BENZENE $C_6H_4F(NO_2)$

Freezing-point data for mixtures of fluoro nitro benzene and chloro nitro benzene are given by Hasselblatt, 1913.

## IODO NITRO BENZENES $C_6H_4INO_2$.

Freezing-point data for mixtures of o, m and p iodo nitro benzenes are given by Holleman, 1913.

## NITRO NITROSO BENZENE m $C_6H_4(NO_2)NO$.

Freezing-point data are given for mixtures of:

m Nitro nitroso benzene + Nitroso mesitylene (Hammick, Edwards, Illingworth and Small, 1933.)
" " " " + Bromo nitroso benzene "
" " " " + Nitroso dimethyl aniline "
" " " " + Nitroso mesitylene "

## DINITRO BENZENES o, m and p $C_6H_4(NO_2)_2$.

100 gms. $H_2O$ dissolve 0.21 gm. ortho, 2.14 gm. meta and 1.32 gm. para dinitro benzene at 20-25°. (Dehn, 1917.)

### Solubility of m Dinitro Benzene in Water and in Organic Solvents.

(Desvergnes, 1925.)

| Solvent | Gms. $C_6H_4(NO_2)_2$(1,3) per 100 gms. solvent at: 15° | 50° | Solvent | Gms. $C_6H_4(NO_2)_2$(1,3) per 100 gms. solvent at: 15° | 50° |
|---|---|---|---|---|---|
| $H_2O$ | 0.0069 | 0.0469 | $C_6H_6$ | 34.09 | 195.89 |
| " | — | 0.1910 (100°) | $CHCl_3$ | 30.51 | 69.48 |
| $CH_3COOC_2H_5$ | 31.09 | 148.44 | $(C_2H_5)_2O$ | 6.74 | 11.06 (30°) |
| $(CH_3)_2CO$ | 72.37 | 213.04 | $C_5H_5N$ | 64.52 | 216.25 |
| $CH_3OH$ | 5.27 | 11.08 | $CS_2$ | 1.23 | 1.38 (33°) |
| 96% $C_2H_5OH$ | 2.37 | 11.49 | $CCl_4$ | 0.97 | 8.97 |
| 100% " | 2.55 | 12.69 | $C_6H_5CH_3$ | 25.66 | 134.80 |
| " " | 5.9 (24.6°) | — | | | |

### Solubility of Dinitrobenzene in Concentrated Aqueous Solutions of Sulfuric Acid. (Hough, Savage and van Marle, 1920.)

The results are given only in the form of a Chart. The following approximate values were read from the published curve.

| t°. | Gms. $C_6H_4(NO_2)_2$ per 100 gms. sat. sol. in 70% $H_2SO_4$. | 80% $H_2SO_4$. | 90% $H_2SO_4$. |
|---|---|---|---|
| 0.... | 0.5 | 1.3 | 7.0 |
| 10.... | 0.6 | 1.35 | 7.2 |
| 20.... | 0.7 | 1.5 | 7.5 |
| 25.... | 0.75 | 1.55 | 7.75 |
| 30.... | 0.8 | 1.6 | 8.0 |
| 40.... | 0.85 | 1.8 | 8.8 |

| t°. | Gms. $C_6H_4(NO_2)_2$ per 100 gms. sat. sol. in 70% $H_2SO_4$. | 80% $H_2SO_4$. | 90% $H_2SO_4$. |
|---|---|---|---|
| 50.... | 0.9 | 2.1 | 9.8 |
| 60.... | 1.0 | 2.6 | 11.1 |
| 70.... | 1.3 | 3.2 | 13.1 |
| 80.... | 1.7 | 3.9 | 15.5 |
| 90.... | 2.0 | 4.7 | 18.2 |
| 100.... | 2.8 | 6.2 | 22.1 |

### Solubility of Meta Dinitrobenzene in Ethyl Acetate.

(Moesveld, 1917, 1918; Cohen and Moesveld, 1919.)

The determinations were made with the greatest possible accuracy. Constant agitation in a thermostat was employed and all precautions taken to insure the purity of the materials and accuracy of the analyses. The results are given to the third place of decimals.

| Gms. *m* $C_6H_4(NO_2)_2$ per 100 gms. sat. sol. | t°. | Gms. *m* $C_6H_4(NO_2)_2$ per 100 gms. sat. sol. | t°. | Gms. *m* $C_6H_4(NO_2)_2$ per 100 gms. sat. sol. |
|---|---|---|---|---|
| 0.02.... 17.89 | 12.5.... | 23.46 | 25.0..... | 30.85 |
| 2.48.... 18.93 | 15.0..... | 24.79 | 27.5..... | 32.61 |
| 5.0..... 19.94 | 17.5..... | 26.17 | 30.0..... | 34.44 |
| 7.5..... 21.02 | 20.0..... | 27.64 | 32.5..... | 36.39 |
| 10.0..... 22.21 | 22.5..... | 29.18 | 35.0..... | 38.40 |

In addition to the above determinations, which were made at the ordinary pressure, results at pressures up to 480 atmospheres are given. These show a diminution of solubility at 30° from 34.44 gms. to 29.567 gms. per 100 gms. sat. sol. at a pressure of 480 atmospheres.

## DiNitro**BENZENE** (*m*) $C_6H_4(NO_2)_2$.

### Solubility in Benzene, Brom Benzene and in Chloroform.

"Synthetic Method."

(Schröder.)

| t°. | Gms $C_6H_4(NO_2)_2$ per 100 Gms Sol. in: | | | t°. | Gms. $C_6H_4(NO_2)_2$ per 100 Gms. Sol. in: | | |
|---|---|---|---|---|---|---|---|
| | $C_6H_6$ | $C_6H_5Br$ | $CHCl_3$ | | $C_6H_6$ | $C_6H_5Br$ | $CHCl_3$. |
| 15 | 17.5 | ... | 22.2 | 40 | 52.0 | 38.0 | 42.0 |
| 20 | 26.0 | 18.5 | 25 0 | 50 | 62.5 | 47.5 | 52.5 |
| 25 | 33.0 | 23.7 | 29 0 | 60 | 71.0 | 57.0 | 65.0 |
| 30 | 40.0 | 28.7 | 33.0 | .. | ... | ... | ... |

### Solubility of *m* Dinitrobenzene in Several Alcohols and Acids

(Timofeiew, 1894.)

| Solvent. | t°. | Gms. *m* $C_6H_4(NO_2)_2$ per 100 Gms. | | Solvent. | t°. | Gms. *m* $C_6H_4(NO_2)_2$ per 100 Gms. | |
|---|---|---|---|---|---|---|---|
| | | Sat. Sol. | Solvent. | | | Sat. Sol. | Solvent. |
| $CH_3OH$ | 13.8 | 5.38 | 5.65 | $CH_3COOH$ | 15.5 | 15.7 | 18.6 |
| $C_2H_5OH$ | 13.8 | 2.83 | 2.92 | " | 23 | 17.8 | 21.6 |
| $C_3H_7OH$ | 13.8 | 2 | 2 | $C_2H_5COOH$ | 13.5 | 12 | 13.6 |
| $C_3H_7OH$ | 73 | 43.6 | 77.3 | " | 15.5 | 12.9 | 14.8 |
| HCOOH | 13.5 | 9 | 9.9 | " | 23 | 13.45 | 15.5 |
| HCOOH | 15.5 | 9.6 | 10.5 | $C_3H_7COOH$ | 13.5 | 7.3 | 8.3 |
| $CH_3COOH$ | 13.5 | 15.2 | 17.9 | " | 15.5 | 8.2 | 8.9 |

100 gms. 95% formic acid dissolve 11.89 gms. *m* dinitrobenzene at 20.8°. (Aschan,'13).
100 gms. pyridine dissolve 106.3 gms. *m* dinitrobenzene at 20°–25°. (Dehn, 1917.)
100 gms. 50% aq. pyridine dissolve 45.5 gms. *m* dinitrobenzene at 20°–25°."

100 gms. sat. solution of di nitro benzene in liquid sulfur dioxide contain about 51 gms. $C_6H_4(NO_2)_2$ (o, m, or p?) at (?) t°.

100 gms. sat. solution in liquid ammonia contain about 19 gms. $C_6H_4(NO_2)_2$. (De Carli, 1927.)

## BENZENE DISULFON CHLORIDES $C_6H_4(SO_2)_2Cl$.

Freezing-point data are given for mixtures of o, m and p Benzene Disulfon chlorides $C_6H_4(SO_2)_2Cl$. (Holleman and Pollak, 1910.)

Freezing-point data are given for mixtures of o, m and p Di nitro benzenes by Andrews, 1925; Wyler, 1932 and Pounder and Masson, 1934.

Results are given for mixtures of Di nitro benzenes and:

Acetanilide(22)
Acenaphthene(6)(14)
Amino azo benzene(38)
Amino phenol(13)
Aniline(1)(5)
Anthracene(31)
Azo benzene(38)
Benzene(2)
Camphor(35)
Carbazole(7)
Cinnamylidene aceto phenone(14a)
Di chloro dinitro benzene
Di methyl amino azo benzene(38)
Di nitro benzenes(39)
Di nitro toluene(14)(16)(40)
" " " + tri nitro toluene(28)
Di phenyl amine(14)
Fluorene(4)(23).
Hydroquinone(15)
Hydroquinone di methyl ether(15)
Naphthalene(1)(5)(17)(25)(26)(29)(30)(36)
Naphthylamines(8)(18)
Naphthol(15)
Naphthol methyl ether(15)
Nitranilines(22)(27)
Nitro benzene(19)(19a)(20)(32)
Nitro erythrite(41)
Nitro glycerine(33)
Nitro mannite(41)
Nitro penta erythrite(41)
Nitro toluene(14)
Oxy benzaldehyde(34)
Phenanthrene(3)
Phenylene diamine(11)(30)
Pyrene(23)
Toluidine(10)
Tri methylene tri nitramine(42)
s Tri nitro benzene(32)
Tri nitro cresol(37)
Tri nitro phenol(40)
Tri nitro phenyl methyl nitramine(37)
Tri nitro toluene(14)(16)(40)
Tri phenyl carbinol(9)
Urea(10)(24)
Urethan(12)

(1) Kremann, 1904; (2) Kremann, 1908; (3) Kremann, et al, 1908; (4) Kremann, 1911; (5) Kremann and Rodinis, 1906; (6) Kremann and Haas, 1919; (7) Kremann and Strzelba, 1921; (8) Kremann and Grasser, 1916; (9) Kremann, Hohl and Müller II, 1921; (10) Kremann and Petritschek, 1917; (11) Kremann and Stroh schneider, 1918; (12) Puschin and Fioletova, 1922; (13) Kremann, Lüpfer and Zawadsky, 1920; (14) Giua, 1915; (14a) Giua, 1925) (15) Giua and Marcellino, 1920; (16) Bogojovlewski, 1918; (17) Kitran, 1924; (18) Rheinboldt, Henning and Kirscheisen, 1925; (19) Lehmstedt, 1918; (19a) Lehmstedt, 1932; (20) Hammick and Hanson, 1933; (21) Macleod, Pfund and Kilpatrick, 1922; (22) Crompton and Whiteley, 1895; (23) Shimomiya, 1940; (24) Van Dorp, Limburg and Nobel, 1937; (25) Kurnakov, Krotkov and Oksman, 1915; (26) Skau, 1930; (27) Johnston and Jones, 1928; (28) Hrynakowski, 1934; (29) Puschin, 1926a; (30) Puschin and Rikovski, 1930; (31) Kremann and Müller II, 1921; (32) Hammick, Andrew and Hampson, 1932; (33) Kurita and Hagui, 1929; (34) Kremann and Pogantsch, 1923; (35) Jefremow, 1916; (36) Olivari, 1911; (37) Jefremow and Tichomirow, 1927; (38) Giua and Reggiani, 1925; (39) Wyler, 1932; (40) Hrynakowski and Kapuscinski, 1933; (41) Urbanski, 1933; (42) Urbanski and Rabek-Gawronska, 1934.

**COMENIC ACID** $C_6H_4O_5$.

100 gms. sat. sol. in water contain 0.51 gm. $C_6H_4O_5$ at 25°. (Verkade, 1924.)
» » in 0.5 molecular $H_3BO_3$ solution contain 0.51 gm. $C_6H_4O_5$ at 25°

## Dinitro PHENOLS $C_6H_3OH(NO_2)_2$ 1.2.3; 1.2.4; 1.2.5 etc.

### Solubility of Isomeric Dinitro Phenols, Each Separately, in Water.

(Sidgwick and Aldous, 1921; Sidgwick and Taylor, 1922.)

The determinations were made by the sealed tube method. The temperature of appearance of two layers, or of disappearance of the last crystal was determined. In indicating the structure of the isomers the hydroxyl group is always assumed to occupy position 1.

Results for the 1.2.3 Compound:

| t°. | Gms. $C_6H_3OH(NO_2)_2$.1.2.3 per 100 gms. sat. sol. | t°. | Gms. $C_6H_3OH(NO_2)_2$.1.2.3 per 100 gms. sat. sol. | t°. | Gms. $C_6H_3OH(NO_2)_2$.1.2.3 per 100 gms. sat. sol. |
|---|---|---|---|---|---|
| 94.5..... | 6.74 | 122.5 (crit. t.). | – | 96.0..... | 74.32* |
| 108.2..... | 10.90 | 120.4..... | 52.15 | 112.3..... | 89.85* |
| 120.1..... | 20.83 | 116.7..... | 60.44 | 145.1 (m. pt.). | 100.00* |
| 122.2..... | 35.13 | 95.0 (tr. pt.). | – | | |

* Solid Dinitro Phenol present.

### Solubility of Isomeric Dinitro Phenols, Each Separately in Water (Con.).

Results for the:

1.2.4 Compound.

| t°. | Gms. $C_6H_3OH(NO_2)_2$1.2.4 per 100 gms. sat. sol. |
|---|---|
| 109.6.. | 1.95 |
| 126.1.. | 2.98 |
| 137.7.. | 3.81 |
| 170.5.. | 8.99 |
| 182.5.. | 12.98 |
| 200.+ crit.t. | – |
| 187.7.. | 86.36 |
| 156.0.. | 93.35 |
| 131.2.. | 97.14 |
| 121.7.. | 97.70 |
| 117.6.. | 98.24 |
| 104.2 tr.pt. | – |
| 108.1.. | 99.02* |
| 112.9 m.pt. | 100.0* |

1.2.5 Compound.

| t°. | Gms. $C_6H_3OH(NO_2)_2$1.2.5 per 100 gms. sat. sol. |
|---|---|
| 124.7... | 2.33 |
| 135.8... | 2.97 |
| 146.4... | 3.91 |
| 162.1... | 5.69 |
| 194.5... | 12.24 |
| 200.+ crit.t. | – |
| 172.2... | 91.73 |
| 146.4... | 94.51 |
| 113.5... | 96.72 |
| 97.5 tr. pt. | – |
| 98.0... | 97.50* |
| 100.0... | 98.48* |
| 105 6 m.pt. | 100.00* |

1.2.6 Compound.

| t°. | Gms. $C_6H_3OH(NO_2)_2$1.2.6 per 100 gms. sat. sol. |
|---|---|
| 71.1... | 0.703 |
| 89.6... | 1.00 |
| 117.6... | 1.87 |
| 139.7... | 3.24 |
| 147.9... | 3.97 |
| 192.5... | 12.27 |
| 200.+ crit.t. | – |
| 158.0... | 93.44 |
| 138.3... | 95.96 |
| 102.6... | 57.80 |
| 84.5... | 98.42 |
| 59.2 tr. pt. | – |
| 59.5... | 99.11* |
| 62.2 m.pt. | 100.00* |

1.3.4 Compound.

| t°. | Gms. $C_6H_3OH(NO_2)_2$1.3.4 per 100 gms. sat. sol. |
|---|---|
| 82.0.. | 6.05 |
| 97.5.. | 12.74 |
| 104.6.. | 23.28 |
| 105.2 crit.t. | 36.65 |
| 101.6.. | 55.40 |
| 73.8.. | 70.23 |
| 52.2 tr.p. | – |
| 53.0.. | 74.91* |
| 84.5.. | 89.43* |
| 134.7 m.pt. | 100.0* |

* Solid dinitro phenol present.

Results for the 1.3.5 Compound:

| t°. | Gms. $C_6H_3OH.(NO_2)_2$1.3.5 per 100 gms. sat. sol. | Solid Phase. |
|---|---|---|
| 51.6.... | 1.36 | $C_6H_3OH(NO_2)_2.2H_2O$ |
| 70.4.... | 3.23 | two liquid layers |
| 109.3.... | 10.83 | » » |
| 124.6 ... | 29.98 | » » |
| 125. crit. t. | – | » » |
| 121.5.... | 57.66 | » » |
| 97.6.... | 69.66 | » » + |
| 54.1 tr. pt. | 77.6 | $C_6H_3OH(NO_2)_2+C_6H_3OH(NO_2)_2.2H_2O$ |

| t°. | Gms. $C_6H_3OH.(NO_2)_2$1.3.5 per 100 gms. sat. sol. | Solid Phase. |
|---|---|---|
| 54.5.... | 79.57 | $C_6H_3OH(NO_2)_2$ |
| 55.5.... | 81.70 | » |
| 57.9.... | 83.64 | » |
| 61.9.... | 86.31 | » |
| 69.9.... | 90.71 | » |
| 81.3.... | 93.00 | » |
| 100.5.... | 96.08 | » |
| 126.1 m.pt. | 100.00 | » |

### Solubility of Isomeric Dinitro Phenols, Each Separately, in Benzene.

(Sidgwick and Aldous, 1921; Sidgwick and Taylor, 1922).

Solid dinitro phenol was present as the solid phase in all cases.

| t°. | Gms. $C_6H_3OH(NO_2)_2$ per 100 gms. sat. sol. | t°. | Gms. $C_6H_3OH(NO_2)_2$ per 100 gms sat. sol | t°. | Gmgs. $C_6H_3OH(NO_2)_2$ per 100 gms. sat. sol. | t°. | Gms. $C_6H_3OH(NO_2)$ per 100 gms. sat. sol. |
|---|---|---|---|---|---|---|---|
| The 1.2.3 cmpd. | | 93.9.... | 79.00 | The 1.2.6 cmpd. | | 113.0.... | 60.49 |
| 78.7.... | 12.77 | 99.5.... | 86.59 | 25.5.... | 43.36 | 116.1.... | 73.10 |
| 93.8.... | 25.30 | 105.6.... | 93.61 | 34.0.... | 60.17 | 122,6.... | 86.64 |
| 102.5.... | 38.66 | The 1.2.5 cmpd. | | 44.5.... | 78.52 | The 1.3.5 cmpd. | |
| 118 6.... | 69.05 | 33.5.... | 13.96 | 50.0.... | 86.87 | 60.9.... | 6.39 |
| 134.9.... | 91.57 | 48.5.... | 24.22 | 55.0.... | 92.85 | 85.0.... | 20.13 |
| The 1.2.4 cmpd. | | 57.0.... | 33.81 | The 1.3.4 cmpd. | | 94.4.... | 32.63 |
| 51.0.... | 21.01 | 67.9.... | 48.91 | 89.2.... | 6.54 | 97.7.... | 51.13 |
| 65.0.... | 34.60 | 71.4.... | 54.78 | 106.5.... | 27.27 | 103.4.... | 73.08 |
| 77.1.... | 52.36 | 82.4.... | 72.97 | 109.1.... | 41.65 | 102.8.... | 83.73 |
| 83.7.... | 62.77 | 88.6.... | 82.44 | 112.1.... | 56.86 | 116.0.... | 94.20 |
| 87.2.... | 69.52 | 98.5.... | 92.90 | | | | |

**DiNitro PHENOL** $C_6H_5.OH.(NO_2)_2$.

100 gms. abs. methyl alcohol dissolve 6.3 gms. $C_6H_3.OH.(NO_2)_2$ at 19.5°.
100 gms. abs. ethyl alcohol dissolve 3.9 gms. $C_6H_3.OH.(NO_2)_2$ at 19.5°. (de Bruyn, '92.)

### Solubility of 1, 2, 4 Dinitro Phenol in Water and Organic Solvents.

(Desvergnes, 1927; 1931a.)

| Solvent | Gms. $C_6H_3(1)OH(2,4)(NO_2)_2$ per 100 gms. solvent at 15° | 50° | Solvent | Gms. $C_6H_3(1)OH(2,4)(NO_2)_2$ per 100 gms. solvent at 15° | 50° |
|---|---|---|---|---|---|
| $H_2O$ | 0.0202(12.5°) | 0.0802 | $C_6H_6$ | 6.39 | 25.67 |
| " | 0.6285(85°) | 1.3488(100°) | $CHCl_3$ | 5.39 | 19.83 |
| $CH_3COOC_2H_5$ | 15.55 | 39.49 | $(C_2H_5)_2O$ | 3.06 | 7.19(t°?) |
| $(CH_3)_2CO$ | 35.90 | 98.33 | $C_5H_5N$ | 20.08 | 70.98* |
| $CH_3OH$ | 4.97 | 16.92 | $CS_2$ | 0.41 | 1.02(t°?) |
| 96% $C_2H_5OH$ | 3.05 | 11.32 | $CCl_4$ | 0.42 | 1.78(t°?) |
| 100% " | 3.77 | 13.29 | $C_6H_5CH_3$ | 6.36 | 19.98 |

* A compound with pyridine is formed.

### Solubility of 1.2.6 Dinitro Phenol in Water and Organic Solvents.

(Desvergnes, 1927; 1931a.)

| Solvent | t° | Gms. $C_6H_3(1)OH(2,6)(NO_2)_2$ per 100 gms. solvent | Solvent | t° | Gms. $C_6H_3(1)OH(2,6)(NO_2)_2$ per 100 gms. solvent |
|---|---|---|---|---|---|
| $H_2O$ | 15 | 0.0315 | $C_6H_6$ | 14 | 33.65 |
| " | 50 | 0.5121 | $CHCl_3$ | " | 31.85 |
| " | 100 | 1.2200 | $(C_2H_5)_2O$ | " | 8.76 |
| $CH_3COOC_2H_5$ | 14 | 68.81 | $C_5H_5N$ | " | 68.04 |
| $(CH_3)_2CO$ | " | 162.21 | $CS_2$ | " | 0.67 |
| $CH_3OH$ | " | 14.74 | $CCl_4$ | " | 0.69 |
| 96% $C_2H_5OH$ | " | 6.50 | $C_6H_5CH_3$ | " | 23.30 |
| 100% " | " | 5.50 | | | |

## Solubility of α Dinitro Phenol in Aqueous Salt Solutions at 25°.

(v. Halban, Kortum and Seiler, 1935.)

The authors give no other identification than α of the di nitro phenol used.

Results for aqueous solutions of:

| Potassium Chloride | | Sodium Chloride | | Barium Chloride | |
|---|---|---|---|---|---|
| Gm. mols. per liter | | Gm. Mols. per liter | | Gm. Equiv. $BaCl_2$ per liter | Gm. Mol. $C_6H_4O_5N_2$ per liter |
| KCl | $C_6H_4O_5N_2$ | NaCl | $C_6H_4O_5N_2$ | | |
| 0.0 | 0.002524 | 0.01209 | 0.002556 | 0.02707 | 0.002567 |
| 0.04523 | 0.002599 | 0.06093 | 0.002551 | 0.05884 | 0.002580 |
| 0.1107 | 0.002623 | 0.1427 | 0.002515 | 0.1310 | 0.002579 |
| 0.2767 | 0.002642 | 0.2059 | 0.002480 | 0.5102 | 0.002459 |
| 0.4482 | 0.002646 | 0.5972 | 0.002278 | 1.0075 | 0.002242 |
| 0.6043 | 0.002646 | 1.043 | 0.002065 | 1.0032 | 0.002240 |
| 0.8696 | 0.002636 | 1.245 | 0.001741 | 1.743 | 0.001950 |
| 1.251 | 0.002614 | 2.084 | 0.001608 | 2.036 | 0.001829 |

| Potassium Perchlorate | | Sodium Perchlorate | |
|---|---|---|---|
| Gm. Mols. per liter | | Gm. Mols. per liter | |
| $KClO_4$ | $C_6H_4O_5N_2$ | $NaClO_4$ | $C_6H_4O_5N_2$ |
| 0.03462 | 0.002632 | 0.04788 | 0.002643 |
| 0.05388 | 0.002670 | 0.1071 | 0.002726 |
| 0.08664 | 0.002734 | 0.2234 | 0.002895 |
| 0.1274 | 0.002811 | 0.4027 | 0.003127 |
| 0.1502 | 0.002859 | 1.0330 | 0.003833 |

Freezing-point data for mixtures of Dinitro benzene + Hydroquinone dimethyl ether are given by Giua and Marcellino, 1920.

## DINITRO PHENOL

Freezing-point data are given for mixtures of 1.2.4 Dinitro phenol and:

Acetanilide(18)(19)
Acenophthene(2)
Acetophenone(3)
Aniline(1)
Anthracene(4)
Antipyrine(2)
Azobenzene(11)
Benzo hydrol(12)
Benzo phenone(3)
Bromo naphthylamine(21)
Camphor(5) (22)
Carbazole(6)
Cinnamic acid(9)
Di methyl oxalate(9)
Di methyl pyrene(17)
Diphenyl amine(7)
Fenchon(8)(15)
Naphthalene(20)
Nitro benzene(10)
Nitro phenol(18)
Oxy benzaldehyde(18)(8)
Phenylene diamines (13)
Pyrene(23)
Quinone(10)
Naphthylamines(28)
Salicylaldehyde(14)
Stiphnic acid(25)
Succinic acid(9)
Succinimide(15)
Tri methyl carbinole(16)
Tri phenyl carbinole(16)
Tri phenyl methane(16)
Tri nitro phenyl methyl nitramine(26)
Urea (24)
Urethan (24)
Fluorene(27)

(1) Kremann, 1906; (2) Kremann and Haas, 1919; (3) Kremann and Marktl, 1920; (4) Kremann and Müller II, 1921; (5) Kremann and Odelga, 1921; (6) Kremann and Slovak, 1920; (7) Kremann and Schadinger, 1919; (8) Kremann and Pogantsch, 1923; (9) Kremann, Zechner and Drazil, 1924; (10) Kremann, Sutter, Sitte, Strzelba and Dobolsky, 1922; (11) Kremann, Zechner and Weber, 1924; (12) Kreman and Drazil, 1924; (13) Kremann and Zawodsky; (14) Kremann and Zechner, 1925; (15) Kremann and Dietrich, 1923; (16) Kremann, Mauermann, Müller and Rosley, 1923; (17) Kendall, 1914(a); (18) Crompton and Whitely, 1895; (19) Tammann and Marktl, 1920; (20) Sapaschinikow, 1904; (21) Hertel and Mischinat, 1926; (22) Hertel and Van Clef, 1928; (23) Schinomiya, 1940; (24) Puschin and Rikovsky, 1932; (25) Jefremow, 1934; (26) Jefremow and Tichomirowa, 1926; (27) Kremann, 1911. (28) Kremann and Grasser, 1916.

**DINITRO RESORCINOLS** 2.4 and 4.6 $(NO_2)_2C_6H_2(OH)_2$.

Freezing-point data for mixtures of dinitro resorcinols and Styphnic acid are given by Jefremow, 1934.

**PICRAMIDE** (1.2.4.6 Tri nitraniline) $NH_2C_6H_2(NO_2)_3$.

100 gms. glycol diacetate ($CH_3.COO.CH_2\ CH_2\ COO.CH_3$, b. pt. 188° 189°.6) dissolve 2.4 gms. $(NO_2)_3C_6H_2.NH_2$ at 25°. (Taylor and Rinkenbach, 1926.)

Freezing-point data are given by Jefremow, 1918, for mixtures of Picramide and each of the following compounds: Anthracene, Acenaphthene, Fluorene, Naphthalene, Phenanthrene, Picric acid and Retene. Results for mixtures of Picramide and Fluoanthene and for Picramide and Pyrene are given by Shinomiya, 1940; Results for Picramide and Tetra nitro methyl aniline are given by Jefremow and Tichomirow, 1928; Results for Tri nitro aniline and naphthalene are given by Grimm, Günther and Titus, 1931.

**BROMO BENZENE** $C_6H_5Br$.

100 gms. $H_2O$ dissolve 0.0446 gm. $C_6H_5Br$ at 30°. (Gross and Saylor, 1931.)

Freezing-point data are given for mixtures of Bromo benzene and:

Chloro benzene (Pascal, 1913; Klemm, Klemm and Schiermann, 1933.)
Iodo " " " " " "
Fluoro " " " " " "
Benzene (Klemm, Klemm & Schiemann, 1933.)
Nitrogen peroxide (Pascal, 1923.)
Di chloro benzene (Timmermans, 1934.)
o Chloro toluene " "

**DIBROM ANILINE** 1.2.4 $NH_2C_6H_3Br_2$.

Freezing-point data for mixtures of Dibrom aniline and Picric acid are given by Hertel, 1924.

**CHLORO BENZENE** $C_6H_5Cl$.

100 gms. $H_2O$ dissolve 0.0488 gm. $C_6H_5Cl$ at 30°. (Gross and Saylor, 1931.)

SOLUBILITY OF CHLOROBENZENE IN SULPHUR.

"Synthetic Method," see page 292.

(Alexejew.)

| t°. | Grams $C_6H_5Cl$ per 100 Grams. Sulphur Layer. | Chlor Benzene Layer. |
|---|---|---|
| 90 | 13 | 70 |
| 100 | 18.5 | 63 |
| 110 | 27 | 53 |
| 116 | crit. temp. | |

Freezing-point data are given for mixtures of Chloro benzene and:

| | | |
|---|---|---|
| Acetic acid(1)(2) | Cyano benzene(4) | Fluoro benzene(4)(7) |
| Benzene(7) | Di bromo ethane(3) | Iodo Benzene(4)(7) |
| Bromo benzene(4)(7) | Di chloro benzene(6) | Nitro benzene(5) |
| Chloro toluene(3)(7) | Ethylene bromide(3) | Pyridine(2) |

(1) Baud, 1913c; (2) Burnham and Madgin, 1936; (3) Linard, 1925; (4) Pascal, 1913; (5) Hrynakowski and Szmyt, 1938a; (6) Timmermans, 1934; (7) Klemm, Klemm and Schiemann, 1933.

**DI CHLOR ANILINE** 1.2.4 $NH_2C_6H_3Cl_2$.

Freezing-point data for mixtures of Dichlor aniline and:

Picric acid (Hertel, 1924.)
Diphenyl amine (Giua and Cherchi, 1919.)

**CHLORO NITRO ANILINES** $NH_2C_6H_3Cl(NO_2)$.

Freezing-points of mixtures of Chloro nitro anilines are given by de Bruyn, 1917.

**FLUORO BENZENE** $C_6H_5F$.

100 gms. $H_2O$ dissolve 0.154 gm. $C_6H_5F$ at 30°. (Gross, Saylor and Gorman, 1933.)

Freezing-point data are given for mixtures of Fluoro benzene and:

| | |
|---|---|
| Benzene(3) | Chloro toluene(2) |
| Bromo benzene(1)(3) | Dichloro benzene(2) |
| Chloro benzene(1)(3) | Iodo benzene(3) |

(1) Pascal, 1913; (2) Timmermans, 1934; (3) Klemm, Klemm and Schiemann, 1933.)

**IODO BENZENE** $C_6H_5I$.

100 gms. $H_2O$ dissolve 0.034 gm. $C_6H_5I$ at 30°. (Gross, Saylor and Gorman, 1933.)

Freezing-point data are given for mixtures of Iodo benzene and:

| | |
|---|---|
| Benzene(2) | Chloro benzenes(1)(2) |
| Bromo benzene(1)(2) | Fluoro benzene(2) |

(1) Pascal, 1913; (2) Klemm, Klemm and Schiemann, 1933.

**BENZENE DIAZONIUM PHOSPHOR FLUORIDE** $C_6H_5N_2PF_6$.

One liter sat. solution in water contains 0.036 gm. mol $C_6H_5N_2PF_6$. (Lange and Muller, 1930.)

**BROMO PHENOLS** $C_6H_4OHBr$.

Freezing-point data are given for:

o Bromo phenol + p Bromo phenol (Holleman and Rinkes, 1911.)
p " " + Tetra methyl phthalan (Bennett and Wain, 1936.)

## Chloro **PHENOLS** *o m* and *p* $C_6H_4OH.Cl$.

### Solubility of Each Separately in Water and in Benzene.

(Sidgwick and Turner, 1922.)

The synthetic method was used at the higher temperatures and the Beckmann freezing-point apparatus at the lower.

### Results for the Solubility in Water :

| Ortho Chloro Phenol. | | Meta Chloro Phenol. | | Para Chloro Phenol. | |
|---|---|---|---|---|---|
| t°. | Wt.% $C_6H_4OH.Cl(o)$. | t°. | Wt.% $C_6H_4OH.Cl(m)$. | t°. | Wt.% $C_6H_4OH.Cl(p)$ |
| − 0.20..... | 1.56(+Ice) | − 0.18..... | 0 73 (+ice) | 0.2..... | 2 07 (+Ice) |
| − 0.30..... | 2.44(+Ice) | + 1.2..... | 1.25 S | 65.0..... | 3.91 L |
| + 82.9..... | 3.76 L | 2.5..... | 1.85 S | 113.8..... | 10.66 L |
| 106.3..... | 5.12 L | 85.25..... | 5 12 L | 125.0..... | 20.5 L |
| 159.1..... | 13.58 L | 118.0..... | 11.13 L | 128.2..... | 29.16 L |
| 165.8..... | 16.45 L | 123.0..... | 13.56 L | 129 crit. t.... | − L |
| 170.7..... | 22.59 L | 127.5..... | 17.84 L | 128.7..... | 42.57 L |
| 173 crit. t.... | 33.00 L | 130.8crit. t... | 32.02 L | 125.8..... | 53.49 L |
| 172.9..... | 45.04 L | 130.7..... | 38.89 L | 122.4..... | 59.62 L |
| 170.1..... | 54.95 L | 130.5..... | 46.12 L | 115.5..... | 65.05L |
| 166.2..... | 60.72 L | 129.1..... | 55.65 L | 107.7..... | 69.36 L |
| 156.6..... | 70.62 L | 109.8..... | 71.23 L | 97.0..... | 74.03 L |
| 118.9..... | 82.82 L | 23.1..... | 82.3 L | 35.5..... | 34.02 L |
| 91.5..... | 85.90 L | 11.8..... | 82.9 L | 17.0..... | 85.42 L |
| 0.3 tr. pt.. | 86.5 LL(+Ice) | 3.2 tr. pt.. | 82.3 LLS | 5.5..... | 86.19 L |
| − 2.0..... | 87.73(+Ice) | − 0.4tr. pt... | 83.4LL(+Ice) | 0.3..... | 86.5 LLS |
| − 4 0..... | 89.25(+Ice) | 3.2(−0.9°). | 84.87(+Ice)*S | 0.5..... | 88.92 S |
| − 5.0..... | 89.62(+Ice) | 4.5..... | 87.19 S | 6.2..... | 92.48 S |
| − 8.0..... | 90.87(+Ice) | − 4.8..... | 88.66(+Ice*) | 11.0..... | 94.48 S |
| − 9.3tr. pt. | 91.2 LS(+Ice) | − 8.2..... | 90.11(+Ice)* | 14.2..... | 95.70 S |
| − 8.2..... | 92.2 S | − 13.2..... | 91.73(+Ice)* | 18.0..... | 96.82 S |
| − 6.0..... | 93.93 S | + 10.8(−17.0°) | 92.23S(+Ice*) | 19.5..... | 97.29 S |
| − 1.5..... | 96.79 S | 17.0..... | 95.1 S | 41.0..... | 100.00 S |
| + 2.0..... | 98.39 S | 22.2..... | 97.1 S | | |
| + 7.0..... | 100.00 S | 32.5..... | 100.0 S | | |

### Results for the Solubility in Benzene :

| | | | | | |
|---|---|---|---|---|---|
| 5.3..... | 0 0 (+$C_6H_6$) | 4.0..... | 4.31(+$C_6H_6$) | 4.5..... | 2.98 (+$C_6H_6$) |
| 4.6..... | 3.04 » | 3.2..... | 7.0 » | 2.4..... | 10.25 » |
| 2.7..... | 8.33 » | 0.5..... | 15.32 » | 1.0..... | 15.10 » |
| 0.0..... | 15.49 » | −1.4..... | 21.40 » | 0.2..... | 17.62 » |
| − 3.2..... | 24.56 » | −4.5..... | 31.77 » | −3.2..... | 29.14 » |
| − 5.0..... | 29.01 » | −6 5..... | 38.39 » | −5.0..... | 35.50 » |
| − 11.6 ..... | 45.22 » | −7.2..... | 40.92 » | −5.5tr. pt... | 37.5 »S |
| − 16.5..... | 55.54 » | −7.0tr. pt.. | 40.0 »S | −3.4..... | 38.07 S |
| − 18.8..... | 60.68 » | −5.3(−7.5°) | 41.66S(+$C_6H_6$*) | −3.2..... | 39 67 » |
| − 19.5tr. pt... | 61.58S » | −4.0..... | 43.62 » | +2.8..... | 45.65 » |
| − 18.5..... | 62.5 S | −8.4..... | 44.9(+$C_6H_6$*) | 6.0..... | 50.10 » |
| − 17.4..... | 63 83 » | −1.5..... | 47.78 S | 9.1..... | 55.24 » |
| − 16.4..... | 64.90 » | 0.0..... | 50.68 » | 12.9..... | 60.53 » |
| − 13.7..... | 69.05 » | 3.4..... | 57.02 » | 18.0..... | 68.58 » |
| − 7.0..... | 80.32 » | 7.4..... | 64.65 » | 20.8..... | 73.13 » |
| − 3.8..... | 84.72 » | 14.2..... | 75.10 » | 25.8..... | 80.06 » |
| + 0.2..... | 90.26 » | 20.0..... | 83.68 » | 30.5..... | 86.65 » |
| 3.6..... | 95.20 » | 24.6..... | 89.89 » | 33.6..... | 90.63 » |
| 5.6..... | 97.65 » | 29.8..... | 96.50 » | 37.5..... | 95.52 » |

+ Ice = ice present. + $C_6H_6$ = Benzene present. S = Solid chlorphenol present. L = Second liquid layer present. * Indicates metastable equilibrium.

The critical solution temperature of mixtures of p-chloro phenol and naphthalene is 58.2°. (Lecat, 1928.)

Freezing-point data for mixtures of Chloro phenols and:

Acetone (Bramley, 1916.)
Aniline " "
Benzylamine (Puschin and Rikovsky, 1937.)
Chloro phenol (Holleman and Rinkes, 1911.)
Di phenyl methyl amine (Bramley, 1916.)
Di methyl aniline (Bramley, 1916.)
Nitrobenzene (Hrynakowski and Szmyt, 1938a.)
Phenyl hydrazine (Puschin and Dimitryeoic, 1936.)
Pyridine (Bramley, 1916.)
Quinoline " "
Toluidine (Burnham and Madgin, 1936.)
Picric acid " " " "

The critical solution temperature of mixtures of p chloro phenol and naphthalene is 58.2° (Lecat 1928.)

**IODO PHENOL** p $C_6H_5OHI$.

Freezing-point data for mixtures of p and o Iodo phenols are given by Holleman and Rinkes, 1911, and for mixtures of Iodo phenol and Tetra methyl phthalan are given by Bennett and Wain, 1936.

**NITROSO BENZENE** $C_6H_5NO$.

Freezing-point data are given for:

Nitroso benzene + Acetic acid (Hammick and Illingworth, 1930.)
" " + Aniline (Kremann, 1904.)
" " + Nitro benzene (Jaeger and Van Kregten, 1912.)
" " + Nitroso toluene (Hammick, Edwards, Illingworth and Small, 1933.)
" " + Nitroso mesitylene (Hammick, Edwards, Illingworth and Small, 1933.)

**NITRO BENZENE** $C_6H_5NO_2$.

SOLUBILITY OF NITROBENZENE IN WATER.

| t° | Gms. $C_6H_5NO_2$ per 100 gms. $H_2O$ | Authority |
|---|---|---|
| 0 | 0.00135(1) | Saylor, Stuckey and Gross, 1938.) |
| 0 | 0.00125 | " " " " |
| 15 | 0.178 | Gross and Saylor, 1931. |
| 30 | 0.205 | " " " |

(1) In this case the nitrobenzene was in the metastable liquid condition (cooled without crystallization below its m. pt. of 5.7°).

MUTUAL SOLUBILITY OF NITROBENZENE AND WATER
(Campetti and Del Grosso, 1913; Davis, 1916.)

| t°. | Gms. $C_6H_5NO_2$ per 100 Gms. $H_2O$ Layer. | Gms. $C_6H_5NO_2$ per 100 Gms. $C_6H_5NO_2$ Layer. |
|---|---|---|
| 20 | 0.19 | 99.76 |
| 40 | 0.3 | 99.6 |
| 60 | 0.4 | 99.3 |
| 80 | 0.8 | 99 |
| 100 | 1 | 98.7 |
| 120 | 1.3 | 98.2 |
| 140 | 1.9 | 97.2 |
| 160 | 2.8 | 95.8 |
| 180 | 4.2 | 93.7 |
| 200 | 7.2 | 91 |
| 220 | 11.8 | 87 |
| 230 | 15.8 | 83 |
| 240 | 23 | 72 |
| 241 | 26 | 67 |
| 242 | 32 | 58 |
| 244.5 | crit. t. 50.1 | |

## Equilibrium in the System Nitrobenzene, Sulfuric Acid and Water.

(Gibby, 1932.)

The binodal curves were determined by titrating aqueous sulfuric acid solutions with nitrobenzene to appearance of turbidity. Tie lines were determined by mixing suitable quantities of the three components to yield two layers and titrating each for sulfuric acid. Determinations were made at 0°, 22° and 34° but the temperature coefficient is so small that the points at the three temperatures all fall upon the same curve.

Binodal curve at 22°

| Gms. per 100 gms. homogeneous mixture | | |
|---|---|---|
| $H_2SO_4$ | $C_6H_5NO_2$ | $H_2O$ |
| 64.0 | 27.3 | 8.7 |
| 79.1 | 4.0 | 16.9 |
| 79.0 | 2.0 | 19.0 |
| 63.7 | 27.7 | 8.6 |
| 61.6 | 38.4 | 0.0 |
| 72.4 | 15.4 | 12.1 |
| 74.2 | 12.8 | 13.0 |
| 76.1 | 10.2 | 13.7 |
| 77.8 | 7.7 | 14.5 |
| 78.5 | 5.7 | 15.8 |
| 79.0 | 4.5 | 16.5 |
| 77.9 | 2.5 | 19.6 |
| 58.6 | 34.1 | 7.3 |
| 62.3 | 29.1 | 8.3 |
| 30.1 | 66.8 | 3.1 |
| 13.3 | 86.7 | 0.0 |
| 76.8 | 1.9 | 21.3 |
| 49.2 | 0.0 | 50.8 |

Tie Lines at 22°

| Total composition Wt. % | | | Gms. $H_2SO_4$ per 100 gms. | |
|---|---|---|---|---|
| $H_2SO_4$ | $C_6H_5NO_2$ | $H_2O$ | $H_2O$ layer | $C_6H_5NO_2$ layer |
| 66.3 | 16.7 | 17.0 | 78.1 | 0.0 |
| 33.4 | 32.4 | 34.2 | 49.5 | 0.0 |
| 48.5 | 26.2 | 25.3 | 64.4 | 0.0 |
| 54.1 | 20.7 | 20.2 | 71.8 | 0.0 |

Solutions in equilibrium with a solid phase at 0°

| Wt. % composition | | | % | Solid |
|---|---|---|---|---|
| $H_2SO_4$ | $C_6H_5NO_2$ | $H_2O$ | $H_2SO_4$ | Phase |
| 83.1 | 1.9 | 15.0 | 79.7 | $H_2SO_4.H_2O$ |
| 85.0 | 0.9 | 14.1 | 86.2 | " |
| 84.1 | 3.2 | 12.7 | 83.9 | " |
| 58.5 | 40.6 | 0.9 | 66.6 | $C_6H_5NO_2.H_2SO_4$ |
| 55.2 | 43.6 | 1.2 | 59.7 | " |
| 38.9 | 60.5 | 0.6 | 34.9 | " |
| 44.6 | 54.8 | 0.6 | 44.2 | " |

## Solubility of Nitrobenzene in Aqueous Solutions of Sulfuric Acid at 25°.

(Hammett and Chapman, 1934.)

| Gms. $H_2SO_4$ per 100 gms. aq. solvent | Gm. Mols. $C_6H_5NO_2$ per liter sat. sol. | Gms. $H_2SO_4$ per 100 gms. aq. solvent | Gm. Mols. $C_6H_5NO_2$ per liter sat. sol. |
|---|---|---|---|
| 0.0 | 0.0158 (= 1.943 gms.) | 58.15 | 0.0255 |
| 19.79 | 0.0097 | 64.30 | 0.0340 |
| 35.82 | 0.0098 | 70.37 | 0.0478 |
| 44.54 | 0.0134 | 74.54 | 0.0729 |
| 48.89 | 0.0155 | 79.28 | 0.1482 |
| 52.76 | 0.0193 | | |

## Solubility of Nitrobenzene in Several Solvents. (von Euler and Svanberg, 1917, 1926.)

| Solvent. | Gms. $C_6H_5NO_2$ per 100 cc. solvent. | Solvent. | Gms. $C_6H_5NO_2$ per 100 cc. solvent. |
|---|---|---|---|
| Water | 0.18 | 1.0*n* Aq. $NH_4$ benzoate | 0.29 |
| 1.0*n* Aq. Na butyrate | 0.19 | 1.0*n* Aq. Na phthalate | 0.13 |
| 1.0*n* Aq. Na isovalerate | 0.17 | 1.0*n* Aq. Na picrate | 0.25 |
| 1.0*n* Aq. aniline nitrate | 0.28 | 1.0*n* Aq. nitric acid | 0.29 |
| 1.0*n* Aq. picoline nitrate | 0.53 | 2.0*n* Aq. K valerate | 0.19 |

100 gms. aq. 0.4 n Na Oleate Solution (= 10.8% Na Oleate) dissolve 4.32 gms. $C_6H_5NO_2$ at 20°. (Smith, 1932.)

100 gms. sat. solution of nitrobenzene in liquid Sulfur Dioxide contain about 50 gms. $C_6H_5NO_2$ at (?) t°.

100 gms. sat. solution of nitrobenzene in liquid Ammonia contain about 24 (?75) gms. $C_6H_5NO_2$ at (?) t°. (De Carli, 1927.)

The critical solution temperature of mixtures of nitrobenzene and hexane is 19°.. (Dessart, 1926.)

The critical solution temperature of mixtures of nitrobenzene and 2.5 Dimethyl hexane (Di iso butyl) is 28.2°. (Timmermans and Hennant-Roland, 1932.)

The critical solution temperature of mixtures of nitrobenzene and borneol is at 70° and the mixture contains 59.8 percent $C_6H_5NO_2$. (Lecat, 1930.)

Data for the mutual solubility of nitrobenzene in hexane, decane and American petroleum in the liquid state at pressures up to 3000 atmospheres, are given by Kohnstamm and Timmermans, 1913.

## Equilibrium in the System Nitrobenzene and Hexane.

(Timofeiew and Stakhorsky, 1926.)

The authors' results were plotted and the following values read from the curve. The freezing-point of nitrobenzene is lowered by hexane to the triple point at which two liquid layers are formed.

Results for the f. pt. curve

| t° | Gms. $C_6H_5NO_2$ per 100 gms. mixture | Solid Phase |
|---|---|---|
| 5.8 | 100 | $C_6H_5NO_2$ |
| 4.0 | 97.5 | " |
| 2.5 | 95.0 | " |
| 1.05 | 92.5 | " |
| 0.0 | 90.0 | " |
| -0.9 | 87.5 | " |
| -1.7 | 85.0 | " |
| -2.4 | 82.5 | " |
| -3.0 | 80 | " |
| -4.0tr.pt. | 77 (Est.) | + 2 liquid layers |

RResults for the liquid layers

| t° | Gms. $C_6H_5NO_2$ per 100 gms. $C_6H_5NO_2$ rich layer | Gms. $C_6H_5NO_2$ per 100 gms. $C_6H_{14}$ rich layer |
|---|---|---|
| 0 | 75.5 | 23.5 |
| 2 | 74.5 | 24.5 |
| 4 | 73 | 26.5 |
| 6 | 70.5 | 29.5 |
| 8 | 66.5 | 34.0 |
| 9 | 64 | 37.0 |
| 10 | 59.5 | 43.5 |
| 10.1 | 59.0 | 44.5 |
| 10.3 | 56.0 | 49.5 |
| 10.4 | 52.0 | 52.0 |

The authors also give the following results for the densities of mixtures of Nitrobenzene and Hexane.

| Wt. % $C_6H_{14}$ | $d\ \frac{15}{4}$ |
|---|---|
| 0.00 | 1.2082 |
| 18.18 | 1.0701 |
| 39.81 | 0.9416 |
| 56.90 | 0.8542 |
| 68.99 | 0.8030 |
| 84.98 | 0.7429 |
| 100.0 | 0.6934 |

| Wt. % $C_6H_{14}$ | $d\ \frac{8}{4}$ |
|---|---|
| 0.0 | 1.2146 |
| 24.99 | 1.0333 |
| 25.70 | 1.0284 |
| 31.76 | 0.9919 |
| 68.81 | 0.8094 |
| 84.66 | 0.7502 |
| 100.0 | 0.7001 |

Results are also given for the viscosities and fluidities of these mixtures.

## Equilibrium in Ternary Mixtures Composed of Nitrobenzene, Hexane and Another Liquid.

(Timofeiew and Stakhorsky, 1926.)

Results for mixtures of Nitrobenzene, Hexane and:

### Resorcinol

| Wt. % $C_6H_5NO_2$ in its mixture with $C_6H_{14}$ | t° of homogeneity when the percentage of m $C_6H_4(OH)_2$ present is: | | |
|---|---|---|---|
| | 0.05 | 0.10 | 0.15 |
| 30.0 | 6.10 | 6.35 | 6.60 |
| 39.94 | 8.90 | 9.22 | 9.50 |
| 39.92 | 10.23 | 10.50 | 10.75 |
| 42.40 | 10.58 | 10.98 | 11.40 |
| 45.99 | 10.80 | 11.26 | 11.66 |
| 54.86 | 10.88 | 11.62 | 12.35 |
| 65.05 | 9.78 | 11.02 | 12.26 |
| 69.82 | 8.70 | 10.60 | 12.12 |

### o Nitrophenol

| Wt. % $C_6H_5NO_2$ in its mixture with $C_6H_{14}$ | t° of homogeneity when the percentage of o $C_6H_4OH(NO_2)$ present is: | | |
|---|---|---|---|
| | 0.5 | 1.0 | 1.5 |
| 30.0 | 6.07 | 6.10 | 6.13 |
| 34.94 | 8.73 | 8.80 | 8.91 |
| 39.92 | 10.02 | 10.15 | 10.28 |
| 42.40 | 10.38 | 10.51 | 10.66 |
| 45.99 | 10.55 | 10.71 | 10.87 |
| 54.86 | 10.35 | 10.57 | 10.78 |
| 65.05 | 8.93 | 9.28 | 9.58 |
| 69.82 | 7.05 | 7.50 | 7.86 |

### Benzoic acid

| Wt. % $C_6H_5NO_2$ in its mixture with $C_6H_{14}$ | t° of homogeneity when the percentage of $C_6H_5COOH$ present is: | | | |
|---|---|---|---|---|
| | 0.0 | 0.5 | 1.0 | 2.0 |
| 29.90 | 6.20 | 5.82 | 5.42 | 4.93 |
| 34.86 | 8.70 | 8.44 | 8.16 | 7.53 |
| 39.91 | 10.05 | 9.88 | 9.66 | 9.22 |
| 46.39 | 10.40 | 10.34 | 10.17 | 9.66 |
| 59.91 | 9.83 | 9.74 | 9.42 | 8.81 |
| 64.93 | 8.56 | 8.50 | 8.36 | 7.75 |
| 69.96 | 6.40 | 6.40 | 6.26 | 5.77 |

### Butyric acid

| Wt. % $C_6H_5NO_2$ in its mixture with $C_6H_{14}$ | t° of homogeneity when the percentage of $C_3H_7COOH$ present is: | | |
|---|---|---|---|
| | 0.0 | 0.5 | 1.0 |
| 29.99 | 6.0 | 5.22 | 4.44 |
| 34.94 | 8.70 | 7.82 | 6.90 |
| 39.92 | 9.90 | 9.06 | 8.22 |
| 42.40 | 10.28 | 9.42 | 8.60 |
| 46.45 | 10.40 | 9.56 | 8.74 |
| 54.86 | 10.14 | 9.32 | 8.47 |
| 65.05 | 8.54 | 7.75 | 6.94 |
| 69.82 | 6.50 | 5.73 | 4.90 |

### Valeric acid

| Wt. % $C_6H_5NO_2$ in its mixture with $C_6H_{14}$ | t° of homogeneity when the percentage of $C_4H_9COOH$ present is: | | |
|---|---|---|---|
| | 0.0 | 0.5 | 1.0 |
| 29.99 | 6.00 | 4.78 | 3.80 |
| 34.82 | 8.62 | 7.50 | 6.50 |
| 39.87 | 10.00 | 8.92 | 7.92 |
| 42.79 | 10.30 | 9.36 | 8.42 |
| 46.37 | 10.40 | 9.47 | 8.57 |
| 59.94 | 10.18 | 9.28 | 8.37 |
| 65.05 | 8.50 | 7.70 | 6.9 |
| 69.82 | 6.50 | 5.77 | 4.97 |

## Freezing-Points of Mixtures of Benzene and Nitrobenzene Saturated with Water. (Simpson and Jones, 1919.)

| t° of freezing. | Gms. $C_6H_6$ per 100 gms. mixture. | t° of freezing. | Gms. $C_6H_6$ per 100 gms. mixture. | t° of freezing. | Gms. $C_6H_6$ per 100 gms. mixture. |
|---|---|---|---|---|---|
| —2.90 | 10.0 | +0.34 | 6.0 | 3.48 | 2.0 |
| —2.08 | 9.0 | 1.14 | 5.0 | 4.34 | 1.0 |
| —1.26 | 8.0 | 1.90 | 4.0 | 5.22 | 0.0 (= wet Nitrobenzene) |
| —0.46 | 7.0 | 2.66 | 3.0 | | |

Freezing-point data for mixtures of benzene and nitrobenzene are also given by Linard, 1925.

## Freezing-Points of Mixtures of Nitrobenzene and Compounds Commonly Associated with it as Impurities. (Simpson and Jones, 1919.)

In each case the freezing-point of mixtures, after saturation with water, was determined.

| Wt. per cent $C_6H_5NO_2$ in mixtures. | Freezing-Points of Binary mixtures of $C_6H_5NO_2$ with | | | | | | |
|---|---|---|---|---|---|---|---|
| | Paraffine. | $CS_2$ | $C_6H_6$. | $m\,C_6H_4(NO_2)$. | $C_6H_5CH_3$. | $o\,C_6H_5CH_3NO_2$. | $p\,C_6H_5CH_3NO_2$. |
| 100... | 5.22 | 5.22 | 5.22 | 5.22 | 5.22 | 5.22 | 5.22 |
| 99... | 4.53 | 4.30 | 4.34 | 4.78 | 4.45 | 4.74 | 4.67 |
| 98... | 3.85 | 3.43 | 3.48 | 4.35 | 3.69 | 4.25 | 4.14 |
| 97... | 3.20 | 2.60 | 2.66 | 3.90 | 3.05 | 3.71 | 3.59 |
| 96... | 2.62 | 1.92 | 1.90 | 3.42 | 2.43 | 3.18 | 3.06 |
| 95... | 2.05 | 1.23 | 1.14 | 2.90 | 1.78 | 2.62 | 2.52 |
| 94... | 1.53 | 0.53 | 0.34 | 2.41 | 1.11 | 2.07 | 2.00 |
| 93... | 1.03 | −0.17 | −0.46 | 1.94 | −0.44 | 1.55 | 1.48 |
| 92... | 0.54 | −0.89 | −1.26 | 1.47 | −0.24 | 1.04 | 0.95 |
| 91... | 0.04 | −1.61 | −2.08 | 1.02 | −0.94 | 0.52 | 0.36 |
| 90... | −0.46 | −2.36 | −2.90 | 0.55 | −16.4 | 0.00 | −0.22 |

## Freezing-Point Data for Mixtures of Benzene and Toluene.

(Robert, 1919.)

| f. pt. | Per cent $C_6H_6$. | f. pt. | Per cent $C_6H_6$. | f. pt. | Per cent $C_6H_6$. | f. pt. | Per cent $C_6H_6$.. |
|---|---|---|---|---|---|---|---|
| 5.5.... | 100 | −12.8... | 70.0 | −39.6... | 40.0 | −80.0.. | 15 |
| 2.8.... | 95 | −16.5... | 65 | −45.4... | 35 | −99.8.. | 12 |
| 0.0.... | 90 | −20.5... | 60 | −51.8... | 30 | −98,0.. | 10 |
| −2.5.... | 85 | −24.8... | 55 | −58.0... | 25 | −96.0.. | 5 |
| −6.0.... | 80 | −29.4... | 50 | −67.4... | 20 | −94.5.. | 0 (=$C_6H_5CH_3$) |
| −9.5.... | 75 | −34.3... | 45 | | | | |

Freezing-point data are given for mixtures of Nitrobenzene and:

Acetic acid(1)(3)(25)
Acetonitrile (8)
Allyl iso sulfocyanide(8)
Allyl sulfocyanate(22)
Aniline(2)(4)
Anthracene(5)
Azoxyanisole(6)
Benzene(1)(2)
Carbon disulfide(23)
Carbon tetra chloride(2)(12)
Chloro benzene(11)
Chloro phenol(11)
Cyclohexane(2)
Di bromo benzene(20)
Di chloro benzene(11)
Di ethyl di acetyl tartrate(18)
Di nitro benzenes(9)(14)(24)(24)
Dinitro phenol(5)
Etheyl acetate(23)
Ethyl ether(16)
Ethylene bromide(1)(2)
Formamide(8)
Hexane(10)(13)(15)
Hydroquinone(5)
Iso pentane(15)
Menthol(18)
Mercuric bromide(19)
Mercuric chloride(19)
Methylene chloride(12)
Naphthols(5)
Naphthalene (4)(21)
Naphthylamine + Quinone(5)
Nitranilines(6)
Nitro benzaldehyde(15)
Nitro methane(8)
Nitro phenols(5)
Nitroso benzene(7)
Phenol(1)(5)
Phenol + Quinone(5)
Pyrogallol(5)
Quinone(5)
Resorcinol(5)
Toluidine(5)
Tri chloro methane(12)
Tri chloro phenol(11)
Tri ethyl amine(8)
Tri nitrobenzene(9)
Tri nitro phenol(5)
Tri nitro toluene(9)
Tri phenyl carbinol(5)
Urea (17)

(1) Dahms, 1895; (2) Linard, 1925; (3) Baud, 1913(c); (4) Kremann, 1904; (5) Kremann, Sutter, Sitte, Strzelba, 1922; (6) Bogojaulouski, Winogradow and Bogolubow, 1906; (7) Jaeger and Van Kregten, 1912; (8) Joukovsky, 1934; (9) Hammick, Andrew and Hampson, 1932; (10) Hartenberg, 1926; (11) Hrynakowski and Szmyt, 1938a; (12) Hrynakowski and Szmyt, 1938; (13) Deffet, 1938; (14) Lehmstedt, 1918, 1932; (15) Timmermans, 1907, 1911; (16) Tsakalotos and Guye, 1910; (17) Van Dorp, Limburg and Nobel, 1937; (18) Scheuer, 1910; (19) Mascarelli and Ascoli, 1907; (20) Schischokin, 1930; (21) Kurnakof et al., 1915; (22) Sisokon, 1928; (23) Timmermans, 1928; (24) Hammick and Hanson, 1933; (25) Hammick and Illingworth, 1930.

**BROMO HYDROQUINONE** $BrC_6H_3(OH)_2$.

Freezing-point data for mixtures of bromo hydro quinone and chloro hydro quinone are given by Küster, 1891. Results are also given for the diacetyl bromo and chloro compounds.

**NITROSO PHENOL** $C_6H_4OHNO$.

Freezing-point data for mixtures of Nitroso phenol and Nitro phenol are given by Jaeger, 1908.

**NitroPHENOLS** $C_6H_4(OH).NO_2$ *o*, *m* and *p*.

SOLUBILITY OF EACH SEPARATELY IN WATER. (Sidgwick, Spurrell and Davies, 1915.)

| t°. | Gms. per 100 Gms. Sat. Sol. | | | t°. | Gms. per 100 Gms Sat. Sol. | | |
|---|---|---|---|---|---|---|---|
| | Ortho. | Meta. | Para. | | Ortho. | Meta. | Para. |
| 40 | 0.330* | 3.02* | 3.28 | 100 | 1.078 | ... | ... |
| 50 | 0.388 | 3.68 | 4.22 | 110 | 1.37 | ... | ... |
| 60 | 0.463 | 4.54 | 5.53 | 120 | 1.59 | ... | ... |
| 70 | 0.560 | 5.80 | 7.50 | 120 | 1.91 | ... | ... |
| 80 | 0.685 | 7.90 | 10.85 | 140 | 2.32 | ... | .. |
| 90 | 0.856 | 11.69 | 21.2 | 150 | 2.90 | ... | ... |
| 92.8 crit. t. | ... | ... | ∞ | 160 | 3.75 | | |
| 98.7 crit. t. | ... | ∞ | ... | 200+ crit. t. | ∞ | | |

* in above table indicates that a solid phase is present.

The above determinations were made by the synthetic method. M. pt. of *o* = 44.9°; of *m* = 95.1°, of *p* = 113.8°. Triple pt. for *o* = 43.5° at conc. 99.48 and 0.35; for *m* = 41.5° at conc. 74 and 3.16; for *p* = 39.6° at conc. 71.2 and 3.26.
One liter sat. solution in water contains 3.89 gms. *o* nitrophenol at 48°.
One liter sat. solution in 1.0 *n o* $C_6H_4(ONa)NO_2$ contains 9.6 gms. *o* nitrophenol at 48°. (Sidgwick, '10.)

100 gms. $H_2O$ dissolve 0.804 gm. p $C_6H_4OHNO_2$ at 15° and 6.052 gms. at 50°. (Desvergnes, 1927.)

100 gms. sat. solution in water contain 0.208 gm. *o* nitrophenol at 20°.
" " " " 2.14 gms. *m* " "
" " " " 1.32 " *p* " " (Vaubel, 1895.)

F.-pt. data for mixtures of *m* nitrophenol and water and for *p* nitrophenol and water are given by Bogojawlewsky, Winogradow, and Bogolubow (1906).

SOLUBILITY OF *m* NITROPHENOL AND OF *p* NITROPHENOL IN AQUEOUS SOLUTIONS OF HYDROCHLORIC ACID AT 25°. (Knox and Richards, 1919.)

Results for *m* Nitrophenol.

| Equiv. Normalities. | | Equiv. Normalities. | |
|---|---|---|---|
| HCl. | $C_6H_4OH.NO_2$ (*m*). | HCl. | $C_6H_4OH.NO_2$ (*m*). |
| 0.0 | 0.0974 | 7.550 | 0.1009 |
| 1.925 | 0.0849 | 9.231 | 0.1130 |
| 3.822 | 0.0834 | 10.96 | 0.1284 |
| 5.720 | 0.0885 | 11.20 | 0.1307 |

Results for *p* Nitrophenol.

| Equiv. Normalities. | | Equiv. Normalities. | |
|---|---|---|---|
| HCl. | $C_6H_4OH.NO_2$ (*p*). | HCl. | $C_6H_4OH.NO_2$ (*p*). |
| 0.00 | 0.1097 | 6.552 | 0.0990 |
| 1.650 | 0.0962 | 8.196 | 0.1093 |
| 3.277 | 0.0913 | 9.817 | 0.1230 |
| 4.993 | 0.0934 | 11.29 | 0.1421 |

SOLUBILITY OF *p* NITROPHENOL (1), *p* NITROANILINE (2), AND *m* NITROANILINE (3), EACH SEPARATELY, IN AQ. SALT SOLUTIONS AT 25°. (Kruyt and Robinson, 1926.)

| Aq. 0.2 *n* solution of: | Gms. per 1000 cc. sat. sol. (1). | (2). | (3). | Aq. 0.2 *n* solution of: | Gms. per 1000 cc. sat. sol. (1). | (2). | (3). |
|---|---|---|---|---|---|---|---|
| No salt (= $H_2O$) | 11.82 | 0.5735 | 0.8929 | $K_2SO_4$ | 11.50 | 0.5430 | 0.8349 |
| KI | 12.45 | 0.6053 | 0.9527 | LiCl | 10.90 | 0.5430 | 0.8449 |
| KBr | 11.91 | 0.5834 | 0.8857 | NaCl | 11.05 | 0.5480 | 0.8514 |
| KCl | 11.55 | 0.5606 | 0.8619 | | | | |

## Solubility of Ortho Nitrophenol in Aqueous Solutions of Methyl Alcohol.

(Duff, 1929.)

NOTE.—In cases where a second liquid layer did not separate the saturated solution was analyzed by evaporation to dryness and weighing the residue. The method used in the cases of formation of liquid was to gradually add nitrophenol to weighed amounts of solvent until a trace just remained undissolved and calculate the solubility from the increase in weight. If an oily layer began to separate the addition of the solid was continued until an excess was present and the solubility again calculated from the increase in weight of the mixture.

Results at 25°

| Wt. % $CH_3OH$ in solvent | Gms. o $C_6H_4OHNO_2$ per 100 gms. sat. sol. |
|---|---|
| 0.0 | 0.25 |
| 30.0 | 0.8 |
| 40.0 | 0.97 |
| 70 | 8.25 |
| 75 | 11.15 |
| 80 | 15.1 |
| 85 | 19.9 |
| 90 | 26.9 |
| 95 | 34.1 |
| 100 | 42.3 |

Results at 40°

| Wt. % $CH_3OH$ in solvent | Gms. o $C_6H_4OHNO_2$ per 100 gms. sat. sol. | |
|---|---|---|
| 0.0 | 0.3 | — |
| 30 | 2.1 | — |
| 35 | 2.5 | 5.5(1) |
| 40 | 3.1 | 25.3(1) |
| 50 | 5.6 | 55.0(1) |
| 60 | 8.4 | 78.5(1) |
| 70 | 21.6 | 90.0(1) |
| 75 | 32.5 | 93.3(1) |
| 80 | 50.5 | 96.3(2) |
| 83 | 72.5 | 96.3(2) |
| 90 | 96.3 | — |
| 100 | 96.6 | — |

(1) Two liquid layers remain at end point.
(2) Two liquids became miscible at end point.

Results for the system Nitrophenol + Acetone + $H_2O$ are given by Waddell, 1899.

## Solubility of Para Nitrophenol in Aqueous Solutions of Methyl Alcohol.

(Duff, 1929.)

See note preceding table.

Results at 25°

| Wt. % $CH_3OH$ in solvent | Gms. p $C_6H_4OHNO_2$ per 100 gms. solvent | |
|---|---|---|
| 0.0 | 2.5 | — |
| 10.0 | 3.1 | — |
| 12.5 | 3.9 | 14.1(1) |
| 15 | 4.8 | 51.5(1) |
| 17.5 | 6.1 | 93.2(1) |
| 20.0 | 9.5 | 134.5(1) |
| 23.0 | 15.0 | 182.6(2) |
| 25 | 20.0(190.2) | 176.0(2) |
| 30 | 56.1(205.3) | 138.3(2) |
| 31.5 | 72.4(207.1) | 123.9(2) |
| 32.5 | 92.3(211.6) | 92.3(2) |
| 35 | (219.5) | |
| 40 | (233.1) | |
| 70 | (265.6) | |
| 100 | (285.3) | |

Results at 40°

| Wt. % $CH_3OH$ in solvent | Gms. p $C_6H_4OHNO_2$ per 100 gms. solvent | |
|---|---|---|
| 0.0 | 2.9 (246.0) | 246.0(3) |
| 3.0 | 3.2 (250.2) | 228.5(3) |
| 4.0 | 3.3 (253.4) | 220.5(3) |
| 5.0 | 3.5 (256.3) | 215.0(3) |
| 10.0 | 5.35(266.1) | 196.2(3)3 |
| 15.0 | 8.7 (275.8) | 176.0(3) |
| 20.0 | 22.8 (286.1) | 153.8(3) |
| 25.0 | 60.5(296.4) | 106.3(3) |
| 25.5 | 75.4 (297.0) | 99.0(3) |
| 27.5 | (304.8) | |
| 30.0 | (310.5) | |
| 35.0 | (318.3) | |
| 40.0 | (322.0) | |
| 70.0 | (339.8) | |
| 100.0 | (359.3) | |

(1) Two liquid phases at end point; (2) One liquid phase at end point
(3) Minimum amount of p nitrophenol required to make two liquid layers miscible.

The results in parentheses in each case are for the upper end of the solubility curve beyond the formation of immiscible layers.

## Solubility of Ortho Nitrophenol in Aqueous Solutions of Ethyl Alcohol at 25°.

(Duff and Bills, 1930.)

| Wt. % $C_2H_5OH$ in solvent | Gms. of $C_6H_4OHNO_2$ per 100 gms. solvent | Wt. % $C_2H_5OH$ in solvent | Gms. of $C_6H_4OHNO_2$ per 100 gms. solvent |
|---|---|---|---|
| 0.0 | 0.25 | 70 | 12.2 |
| 30.0 | 0.7 | 80 | 21.0 |
| 40 | 1.7 | 90 | 32.5 |
| 50 | 3.9 | 100 | 46.0 |
| 60 | 7.4 | | |

## Solubility of Meta Nitrophenol in Aqueous Solutions of Ethyl Alcohol.

(Duff and Bills, 1930.)

| Results at 0° | | Results at 12.5° | | | Results at 25° | | |
|---|---|---|---|---|---|---|---|
| Wt. % $C_2H_5OH$ in solvent | Gms. of $C_6H_4OHNO_2$ per 100 gms. solvent | Wt. % $C_2H_5OH$ in solvent | Gms. of $C_6H_4OHNO_2$ per 100 gms. solvent | | Wt. % $C_2H_5OH$ in solvent | Gms. of $C_6H_4OHNO_2$ per 100 gms. solvent | |
| 0.0 | 0.9 | 0 | 1.2 | | 0 | 1.35 | |
| 20 | 1.6 | 20 | 2.5 | | 10 | 1.7 | |
| 30 | 5.0 | 25 | 6.8 | 10.3(1) | 15 | 4.0 | 5.9(1) |
| 40 | 19.8 | 27.5 | 8.9 | 17.9(1) | 20 | 6.5 | 38.8(1) |
| 50 | 36.8 | 30 | 12.8 | 30.5(1) | 25 | 11.0 | 76.5(1) |
| 60 | 53.7 | 35 | 27.2 | 51.0(1) | 30 | 25.0 | 106.3(1) |
| 70 | 71.5 | 40 | 41.0 | 71.5(1) | 35 | 43.5 | 147.0(1) |
| 80 | 89.5 | 42 | 52.1 | 80.5(1) | 37.5 | 52.2 (156) | 142.0(2) |
| 90 | 106.6 | 45 | 74.4 | 92.0(1) | 39.0 | 59.8 (162) | 140.0(2) |
| 100 | 115.5 | 46 | 96.0 | | 40.0 | 65.8 (165) | 135.0(2) |
| | | 50 | 106.2 | | 41.0 | 81.5 (167) | 122.5(2) |
| | | 60 | 126.2 | | 42.0 | (171) | |
| | | 63 | 131.0 | | 50 | (189) | |
| | | 70 | 139.5 | | 63 | (204) | |
| | | 80 | 143.5 | | 70 | (202) | |
| | | 90 | 146.0 | | 80 | (200) | |
| | | 100 | 148.0 | | 100 | (195) | |

(1) Two liquid phases remain at end point.
(2) Two liquids became miscible at end point.
The results in parentheses are for the curve beyond the formation of immiscible layers.

## Solubility of Para Nitrophenol in Aqueous Solutions of Ethyl Alcohol.

(Duff and Bills, 1930.)

| Results at 0° | | Results at 25° | | | Results at 40° | | |
|---|---|---|---|---|---|---|---|
| Wt. % $C_2H_5OH$ in solvent | Gms. p $C_6H_4OHNO_2$ per 100 gms. solvent | Wt. % $C_2H_5OH$ in solvent | Gms. p $C_6H_4OHNO_2$ per 100 gms. solvent | | Wt. % $C_2H_5OH$ in solvent | Gms. p $C_6H_4OHNO_2$ per 100 gms. solvent | |
| 0 | 0.5 | 0.0 | 1.6 | — | 0 | 2.9 (246) | 246(2) |
| 10 | 0.6 | 9 | — | 7.8(1) | 10 | 5.5 (258) | 233(2) |
| 25 | 1.4 | 10 | 3.4 | 17.5(1) | 15 | 9.0 (268) | 220(2) |
| 27.5 | — 9.2(1) | 12.5 | — | 42.5(1) | 20 | 19.0 (277) | 206(2) |
| 30 | 5.2 15.2(1) | 15.0 | 5.2 | 65.6(1) | 25 | 36.5 (286) | 190(2) |
| 35 | 12.5 30.0(1) | 17.5 | 6.0 | 95.6(1) | 30 | 55.1 (296) | 149(2) |
| 40 | 25.0 44.8(1) | 20.0 | 8.5 | 118.7(1) | 32.5 | 79.5 (299) | 114(2) |
| 45 | 41.0 61.0(1) | 22.5 | 13.7 | 141.6(1) | 33.3 | 95.0 — | 101(2) |
| 50 | 58.5 76.0(1) | 25.0 | 19.2 | 169.1(1) | 33.8 | (300.5) | — |
| 51 | 82.0 | 27.5 | 26.2 (194) | 191. (2) | 35.0 | (303) | |
| 54 | 96.0 | 30 | 34.9 (198) | 177.1(2) | 39 | (306) | |
| 56 | 101.0 | 32.5 | 45.7(206.1) | 160.5(2) | 40 | (305) | |
| 60 | 108.0 | 35 | 57.8(210.5) | 147.9(2) | 50 | (298) | |
| 70 | 120.0 | 37.5 | 70.1(217.9) | 132.7(2) | 60 | (289) | |
| 80 | 118.0 | 38.5 | 80.5(218.7) | 117.6(2) | 70 | (276) | |
| 90 | 117.0 | 40 | (220.5) | | 80 | (265) | |
| 100 | 116.4 | 56 | (230.4) | | 90 | (255) | |
| | | 70 | (220.0) | | 100 | (250) | |
| | | 90 | (199.0) | | | | |
| | | 100 | (189.5) | | | | |

(1) Two liquid phases remain at end point.
(2) Two liquids become miscible at end point.
The results in parentheses are for the curve beyond the formation of immiscible layers.

## Solubility of Ortho and of Para Nitrophenol, Each Separately, in Several Solvents.

(Desvergnes, 1927.)

| Solvent | Gms. per 100 gms. solvent: o $C_6H_5O_3N$ at 15.5° | p $C_6H_5O_3N$ at 14° | Solvent | Gms. per 100 gms. solvent o $C_6H_5O_3N$ at 15.5° | p $C_6H_5O_3N$ at 14° |
|---|---|---|---|---|---|
| $CH_3COOC_2H_5$ | 130.95 | 126.26 | $CHCl_3$ | 99.68 | 2.99 |
| $(CH_3)_2CO$ | 69.14 | 205.08 | $(C_2H_5)_2O$ | 95.03 | 130.35(34°) |
| $CH_3OH$ | 11.83 | 240.45 | $C_5H_5N$ | 144.44 | 71.20 |
| 96% $C_2H_5OH$ | 25.31 | 160.90 | $CS_2$ | 47.59 | 0.05(34.5°) |
| 100% " | 24.55 | 150.92 | $CCl_4$ | 40.42 | 0.05 |
| $C_6H_6$ | 107.38 | 1.28 | $C_6H_5CH_3$ | 45.28 | 1.13 |

## Solubility of *o* Nitrophenol in Liquid Carbon Dioxide. (Büchner, 1905–6.)

| t°. | Gms. o $C_6H_4(OH)NO_2$ per 100 Gms. Sat. Sol. | t°. | Gms. o $C_6H_4(OH)NO_2$ per 100 Gms. Sat. Sol. |
|---|---|---|---|
| −52 | 1.9 | 12.5 | 10 |
| −40 | 2.5 | 14 | 21.2 |
| −20 | 3.8 | 15 | 33.8 |
| 0 | 5.2 | 16 | 48.5 |
| +10 | 7.7 | 20 | 60.7 |

100 gms. 95% formic acid dissolve 16.06 gms. *o* $C_6H_4(OH)NO_2$ at 20.8°. (Aschan, '13.)
100 gms. 95% formic acid dissolve 23.44 gms. *p* $C_6H_4(OH)NO_2$ at 18.6°. "
One liter of sat. solution of the pale yellow form of *p* nitrophenol in benzene, contains 7.1 gms. *p* $C_6H_4(OH)NO_2$ at 5°, determined by the f.-pt. method. (Sidgwick, 1915.)

SOLUBILITY OF THE THREE NITROPHENOLS, SEPARATELY, IN TOLUENE, BROMOBENZENE AND IN ETHYLENE DIBROMIDE. (Sidgwick, Spurrell and Davies, 1915.)

| t°. | Gms. *o* $C_6H_4(OH)NO_2$ per 100 Gms. Sat. Sol. In $C_6H_5CH_3$. | In $C_6H_5Br$. | In $C_2H_4Br_2$. |
|---|---|---|---|
| 15 | 46.9 | ... | 40 |
| 20 | 55.2 | 48.8 | 47.8 |
| 25 | 64.6 | 57.7 | 56.8 |
| 30 | 74.6 | 67.2 | 67.2 |
| 35 | 84.5 | 78.3 | 79 |
| 40 | 93.1 | 89.7 | 90.6 |

| t°. | Gms. *p* $C_6H_4(OH)NO_2$ per 100 Gms. Sat. Sol. In $C_6H_5CH_3$. | In $C_6H_5Br$. | In $C_2H_4Br_2$. |
|---|---|---|---|
| 70 | 18.5 | ... | 31 |
| 80 | 28.1 | 32.7 | 52 |
| 90 | 54.4 | 59.7 | 73.2 |
| 100 | 79.6 | 80.6 | 88.5 |
| 110 | 96.3 | 96.3 | 98 |

| t°. | Gms. *m* $C_6H_4(OH)NO_2$ per 100 Gms. Sat. Sol. in $C_6H_5CH_3$. | t°. | Gms. *m* $C_6H_4(OH)NO_2$ per 100 Gms. Sat. Sol. in $C_6H_5CH_3$. | t°. | Gms. *m* $C_6H_4(OH)NO_2$ per 100 Gms. Sat. Sol. in $C_6H_5CH_3$. |
|---|---|---|---|---|---|
| 39.6 | 4.63 | 64.8 | 16.44 | 78.5 | 70.50 |
| 45.8 | 6 | 67.7 | 20.26 | 82.3 | 79.57 |
| 48.9 | 7.03 | 71.5 | 33.16 | 88.8 | 91.43 |
| 54 | 9.11 | 74.5 | 46.93 | 95.1 | 100 |
| 58 | 11.28 | 75.7 | 57.71 | | |

SOLUBILITY OF *o*, *m* AND *p* NITROPHENOL EACH SEPARATELY, IN SEVERAL ORGANIC SOLVENTS. (Carrick, 1921.)

Since saturation is reached very quickly with these compounds the determinations were made by adding to a carefully weighed glass stoppered flask, an accurately weighed amount of the solid and then a small amount of the solvent. The mixture was warmed slowly, while being constantly agitated, untill the solid just disappeared. The temperature was observed and the amount of solvent present determined by carefully weighing the flask. Succeeding determinations were made in exactly the same manner after adding additional amounts of the solvent.

| Ortho Nitrophenol. | | | Meta Nitrophenol. | | | Para Nitrophenol. | | |
|---|---|---|---|---|---|---|---|---|
| | Gms. $C_6H_4OH.NO_2(o)$ per | | | Gms. $C_6H_4OH.NO_2(m)$ per | | | Gms. $C_6H_4OH.NO_2(p)$ per | |
| t°. | 100 gms. solvent. | 100 gms. sat. sol. | t°. | 100 gms. solvent. | 100 gms. sat. sol | t°. | 100 gms. solvent. | 100 gms. sat. sol. |
| RESULTS FOR THE SOLUBILITY IN ACETONE : | | | | | | | | |
| +0.2... | 102.44 | 50.60 | +0.2... | 169.35 | 62.95 | 0.0... | 188.28 | 66.99 |
| 6.0... | 131.42 | 56.79 | 10.1... | 190.91 | 65.63 | 10.1... | 204.47 | 67.15 |
| 11.5... | 166.48 | 62.48 | 25.0... | 223.43 | 69.08 | 24.6... | 229.8 | 69.66 |
| 16.1... | 211.37 | 67.88 | 34.5... | 255.22 | 71.85 | 33.2... | 262.74 | 72.43 |
| 20.1... | 258.96 | 70.50 | 43.0... | 301.32 | 75.08 | 41.2... | 284.10 | 73.97 |
| 26.1... | 398.97 | 79.97 | 55.2... | 422.81 | 80.87 | 50.4... | 327.92 | 76.63 |
| 30.3... | 566.29 | 84.98 | 63.0... | 533.20 | 84.21 | 61.7... | 408.86 | 80.16 |
| 36.5... | 1236.67 | 92.50 | 74.5... | 905.20 | 90.05 | 75.2... | 546.81 | 84.54 |
| | | | 84.0... | 1305 88 | 92.88 | 85.6... | 791.31 | 88.78 |
| | | | | | | 97.0... | 1192.50 | 92.30 |
| RESULTS FOR THE SOLUBILITY IN BENZENE : | | | | | | | | |
| 0.0... | 45.89 | 31.45 | 6.0... | 0.63 | 0.62 | 8.0... | 0.65 | 0.64 |
| 6,0... | 68.11 | 40.51 | 22.0... | 1.83 | 1.79 | 20.1... | 0.96 | 0.95 |
| 14.1... | 103.84 | 50.94 | 38.0... | 4.99 | 4.75 | 32.1... | 1.67 | 1.63 |
| 20.1... | 148.3 | 59.72 | 48.0... | 9.86 | 9.18 | 41.3... | 2.83 | 2.75 |
| 26.9... | 246.49 | 72.79 | 57.5... | 20.96 | 17.37 | 65.5... | 8.79 | 8.08 |
| 30.1... | 365.41 | 78.51 | 66.0... | 45.94 | 31.48 | 73.5... | 15.99 | 13.78 |
| 34.6... | 561.59 | 84.88 | 74.0... | 120.43 | 54.63 | 78.5... | 25.18 | 20.11 |
| 40.1... | 873.57 | 89.73 | 81.5... | 375.51 | 79.05 | 85.4... | 61.71 | 38.09 |
| | | | 85.0... | 571.09 | 84.98 | 91.0*. | 124.54 | 56.05 |
| | | | 87.8*. | 852.51 | 89.55 | 96.5*. | 400.02 | 80.00 |
| | | | | | | 104.2*. | 1071.96 | 91.54 |

* Sealed tubes were used.

## Solubility of *o*, *m* and *p* Nitrophenol, Each Separately, in Several Organic Solvents. (Con.).

| Ortho Nitrophenol. | | | Meta Nitrophenol. | | | Para Nitrophenol. | | |
|---|---|---|---|---|---|---|---|---|
| | Gms. $C_6H_4OH.NO_2(o)$ per | | | Gms. $C_6H_4OH.NO_2(m)$ per | | | Gms. $C_6H_4OH.NO_2(p)$ per | |
| t°. | 100 gms. solvent. | 100 gms. sat. sol. | t°. | 100 gms. solvent. | 100 gms. sat. sol. | t°. | 100 gms. solvent. | 100 gms. sat. sol. |
| **Results for the Solubility in Ethyl Alcohol :** | | | | | | | | |
| 0.0.. | 10.16 | 9.22 | 1.0.. | 116.91 | 53.87 | 0.0.. | 115.75 | 53.65 |
| 6.7.. | 13.00 | 11.50 | 11.0.. | 143.55 | 58.94 | 10.0.. | 133.84 | 57.23 |
| 12.4.. | 17.71 | 15.04 | 23.4.. | 183.77 | 64.75 | 18.5.. | 161.13 | 61.70 |
| 17.3.. | 22.08 | 18.09 | 30.5. | 221.24 | 69.03 | 26.1.. | 193.78 | 65.96 |
| 23.1.. | 34.31 | 25.54 | 45.5.. | 301.54 | 75.20 | 38.6.. | 244.89 | 71.01 |
| 30.2.. | 60.58 | 41.03 | 50.7.. | 345.27 | 77.54 | 45.2.. | 278.94 | 73.61 |
| 34.3.. | 200.00 | 66.67 | 57.5.. | 422.62 | 80.87 | 52.7.. | 319.52 | 77.16 |
| 37.3.. | 545.48 | 86.68 | 65.5.. | 554.25 | 84.71 | 62.7.. | 415.55 | 80.60 |
| 41.3.. | 1038.44 | 91.22 | 77.2.. | 851.47 | 89.49 | 71.2.. | 545.00 | 84.50 |
| | | | 85.0.. | 1105.25 | 91.72 | 81.1.. | 800.38 | 88.89 |
| | | | | | | 89.8.. | 1016.75 | 91.05 |
| **Results for the Solubility in Ethyl Ether.** | | | | | | | | |
| 1.0.. | 37.76 | 27.41 | +0.2.. | 105.92 | 51.44 | 1.0.. | 109.99 | 52.38 |
| 5.5.. | 44.81 | 30.95 | 8.2.. | 118.20 | 54.17 | 10.1.. | 115.56 | 53.61 |
| 10.5.. | 59.41 | 37.27 | 12.2.. | 127.24 | 55.99 | 18.0.. | 122.95 | 55.06 |
| 15.8.. | 81.07 | 44.75 | 23.5.. | 143.67 | 58.96 | 24.1.. | 131.18 | 56.74 |
| 21.9.. | 138.79 | 58.12 | 39.5.. | 178.74 | 63.89 | 28.7.. | 133.02 | 57.07 |
| 27.8.. | 249.45 | 71.38 | 48.5.. | 212.75 | 68.02 | 31.7.. | 139.23 | 58.20 |
| 33.2.. | 480.61 | 82.79 | 59.0.. | 269.22 | 72.92 | 38.1.. | 149.29 | 59.89 |
| 37.5.. | 915.45 | 90.23 | 68.0.. | 355.06 | 78.03 | 46.8.. | 167.66 | 62.64 |
| | | | 75.0.. | 508.89 | 83.58 | 59.9.. | 202.07 | 66.89 |
| | | | 83.0.. | 1065.84 | 91.42 | 70.5.. | 249.39 | 71.38 |
| | | | | | | 87.8*. | 380.29 | 79.23 |
| | | | | | | 97.1*. | 586.58 | 85.51 |
| | | | | | | 101.9*. | 1001.50 | 90.92 |

* Sealed tubes were used.

## Solubility of Ortho Nitrophenol in Mixtures of Alcohol and Quinoline at 20-25°. (Pucher and Dehn, 1921.)

| Per cent $C_7H_9N$ in solvent. | Gms. $C_6H_4OHNO_2(o)$ per 100 gms. solvent (?). | Per cent $C_7H_9N$ in solvent. | Gms. $C_6H_4OHNO_2(o)$ per 100 gms. solvent (?). | Per cent $C_7H_9N$ in solvent. | Gms. $C_6H_4OHNO_2(o)$ per 100 gms. solvent (?). |
|---|---|---|---|---|---|
| 0.0 (=$C_2H_5OH$). | 404 | 47.5..... | 1008 | 80..... | 1296 |
| 10.0..... | 504 | 50.0..... | 1005 | 90..... | 1367 |
| 23.2..... | 720 | 60.0..... | 1152 | 100..... | 1450 |
| 37.5..... | 864 | 70.0..... | 1224 | | |

The critical solution temperature of mixtures of o Nitrophenol and Naphthalene is 42.5°. (Lecat, 1929.)

Freezing-point data are given for mixtures of Nitrophenols and:

Acenaphthene(10)
Acetamide(42)
Aceto phenone(5)
Acetyl o Nitrophenol(24)
Amino phenols(6)
Aniline(3)
Anthracene(16)
Antipyrine(10)
Azobenzene(38)
Benzal acetophenone(1)
Benzamide(22)(42)
Benzene(31)
Benzohhydrol(39)
Benzo phenone(7)
Camphor(11)(28)
Carbazole(13)
Cineole(29)
Cinnamic acid(33)
Cinnamic aldehyde(7)
Di methyl oxalate(33)
Di methyl pyrone(18)
Di nitro phenol(25)
Di phenyl amine(15)(21)
Di phenyl methane(14)
Fenchon(8)
Methylene dioxybenzal aceto phenone(1)
Naphthalene(2)(23)(27)
Nitraline(40)
Nitro benzene(9)
Nitro chloro benzene(40)
Nitro phenols(26)
Nitroso phenol(20)
Oxybenzaldehyde(34)
Nitro toluene 37)
Nitro mannite(41)
Phenylene diamine(4)
Picric acid(3)
Quinone(9)
Salicylaldehyde(7)
Styph nic acid(36)
Succinimide(8)
Succinic acid(33)
Sulfuric acid(19)
Toluidine(4)(29)(30)
Tri chloro acetic acid(17)
Tri methyl carbinol(32)
Tri nitro phenyl methyl nitramine(35)
Tri phenyl carbinol(16)
Tri phenyl methane(12)
Urea(3)
Naphthylamines (43)

(1) Asahina, 1934; (2) Kremann, 1904; (3) Kremann and Rodinis, 1906; (4) Kremann and Petritschek, 1917; (5) Kremann and Marktl, 1920; (6) Kremann, Lupfer and Zawodsky, 1920; (7) Kremann and Zechner, 1918, 1926; (8) Kremann and Dietrich, 1923; (9) Kremann, Sutter, Sitte, Strzelba, and Dobolzsky, 1922; (10) Kremann and Haas, 1919; (11) Kremann and Odelga, 1921; (12) Kremann, Odelga and Zawodsky, 1921; (13) Kremann and Slovak, 1920; (14) Kremann and Fritsch, 1920; (15) Kremann and Schadinger, 1919; (16) Kremann and Müller, II, 1921; (17) Kendall, 1916; (18) Kendall, 1914a; (19) Kendall and Carpenter, 1914; (20) Jaeger, 1908; (21) Giua and Cherchi, 1919; (22) Puschin and Rikovski, 1930; (23) Rheinboldt, Henning and Kirscheisen, 1925; (24) Boesken, 1912; (25) Crompton and Whiteby, 1895; (26) Carrick, 1921; (27) Saposchinikov, 1904; (28) Jefremov, 1919; (29) Pawlewski, 1893; (30) Philip, 1903; (31) Bogojawlensky, Winogradow and Bogobubow, 1906; (32) Kremann, Mauermann, Müller, II, and Rösler, 1922; (33) Kremann, Zechner and Drazil, 1924; (34) Kremann and Pogantsch, 1923; (35) Jefremow and Tichomirowa, 1926; (36) Jefremow, 1934; (37) Crockford and Simmons, 1933; (38) Kremann, Zechner and Weber, 1924; (39) Kremann and Drazil, 1924; (40) Grimm, Günther and Titus, 1931; (41) Urbanski, 1934; (42) Kremann and Auer, 1918. (43) Kremann and Grasser, 1916.

## NITRO HYDROQUINONE, NITRO PYROCATECHOL, NITRO RESORCINOL $NO_2C_6H_3(OH)_2$

Freezing-point data for mixtures of each of these compounds and Styphnic acid are given by Jefremow, 1934. Results for mixtures of each of these compounds and Camphor are given by Jefremow, 1919, and Kremann and Odelga, 1921.

## DI NITRO ANILINE $(NO_2)_2C_6H_3NH_2$.

Freezing-point data for mixtures of 2.4 dinitro aniline and 2.4.6 tetra nitro methyl aniline are given by Jefremow and Tichomirowa, 1928.

## BENZENE $C_6H_6$.

### Solubility of Benzene in Water.

The results of Hill, 1922; Barbaudy, 1926b; Uspenski, 1929; and Gross and Saylor, 1931, were plotted and the following values taken from the average curve.

| t° | Gms. $C_6H_6$ per 100 gms. $H_2O$ | t° | Gms. $C_6H_6$ per 100 gms. $H_2O$ | t° | Gms. $C_6H_6$ per 100 gms. $H_2O$ |
|---|---|---|---|---|---|
| 0 | 0.153 | 30 | 0.190 | 70 | 0.277 |
| 10 | 0.163 | 40 | 0.206 | 80 | 0.325 |
| 20 | 0.175 | 50 | 0.225 | 90 | 0.395 |
| 25 | 0.180 | 60 | 0.250 | 107.4 | 0.507 |

### Solubility of Water in Benzene.

The results of Groschuff, 1911; Clifford, 1921; Rosenbaum and Walton, 1930; and Tarassenkow and Poloshinzewa, 1932, were plotted and the following values taken from the average curve.

| t° | Gms. $H_2O$ per 100 gms. $C_6H_6$ | t° | Gms. $H_2O$ per 100 gms. $C_6H_6$ | t° | Gms. $H_2O$ per 100 gms. $C_6H_6$ |
|---|---|---|---|---|---|
| 0 | 0.0275 | 30 | 0.072 | 60 | 0.256 |
| 10 | 0.036 | 40 | 0.102 | 70 | 0.280 |
| 20 | 0.050 | 50 | 0.147 | 80 | 0.367 |
| 25 | 0.060 | | | | |

The partial vapor pressures at 30° of aqueous solutions of benzene are given by Saylor, Stuckey and Gross, 1938.

### Solubility of Benzene Vapor in Water at 25°. (Milligan, 1925.)

A mixture of air and benzene vapor of known composition was shaken with water at 25° and the residual mixture analyzed by means of a Haldane gas analysis apparatus. The amount of benzene vapor dissolved was thus found by difference. The coefficient of solubility (volume of gas, reduced to 0°, which dissolves in one volume of water at 25°, when the pressure of the gas over the water is 760 mm.) was found to be $\alpha_{25} = 1.5$.

From this value it was calculated that approximately 0.07 cc. of liquid benzene is dissolved by 100 cc. of $H_2O$ at 25°.

### Solubility of Benzene in Super-heated Water. (Jaeger, 1923.)

The determinations were made in a large shaking autoclave. Mixtures of 500 cc. of benzene and 2 liters of water were shaken 10 minutes at each temperature, and then allowed to stand 20 minutes, 500 cc. of the solution was withdrawn and allowed to stand a day. The volume of separated oil was then carefully determined.

| t° | 100°. | 150°. | 200°. | 250°. | 285°. | 300°. |
|---|---|---|---|---|---|---|
| cc. $C_6H_6$ dissolved per 100 cc. $H_2O$ | 0.2 | 0.6 | 2.1 | 7.3 | 10.6 | 14.6 |

The following values were obtained for :

Solvent Benzol (b. pt. 140°-190°).

| t° | 150°. | 200°. | 25°. |
|---|---|---|---|
| Gms. solvent benzol per 100 cc. $H_2O$ | 0.04 | 0.17 | 1.15 |

Pure Benzin from Petroleum (b. pt. 65°–100°).

| t | 150°. | 200°. | 250°. |
|---|---|---|---|
| Gms Benzin per 100 cc. $H_2O$ | 0.04 | 0.2 | 0.9 |

100 gms. Aq. 0.4 n Sodium Oleate Solution (= 10.8 gm. Na Oleate per 100 gms. solution) dissolve 4.0 gms. $C_6H_6$ directly and 11.9 gms. by mixing benzene and oleic acid and adding the calculated amount of NaOH to neutralize the oleic acid, followed by dilution with $H_2O$ to 0.4 normality. (Smith, 1932.)

100 gms. anhydrous formic acid dissolve 15.14 gms. $C_6H_6$ at 25°. (Gordon and Reid, 1922.)

## The System Benzene, Phenol and Water at 25°.

(Horiba, 1914.)

In the case of phenol, the bromine method was used for its determination. In the case of the other two compounds, the amounts required to produce constant turbidity were measured directly from burettes.

Solubility of Benzene in Aqueous Solutions Containing Phenol and Vice Versa.

| $d_{25°}$ | Gms. per 100 Gms. $C_6H_5OH+C_6H_6+H_2O$. | | Saturating Phase. |
|---|---|---|---|
| | $C_6H_5OH$. | $C_6H_6$. | |
| 1.0002 | 0 | 0.198 | $C_6H_6$ |
| 1.0008 | 1.059 | 0.204 | " |
| 1.0021 | 2.602 | 0.205 | " |
| 1.00305 | 3.526 | 0.199 | " |
| ... | 5.65 | 0.17 | $C_6H_6+C_6H_5OH$ |
| ... | 5.953 | 0.132 | $C_6H_5OH$ |
| 1.0059 | 6.516 | 0.075 | " |
| 1.0069 | 7.683 | 0.025 | " |
| 1.0073 | 8.195 | 0 | " |

Solubility of Phenol in Benzene Solutions Containing Water and Vice Versa.

| $d_{25°}$ | Gms. per 100 Gms. $C_6H_5OH+C_6H_6+H_2O$. | | Saturating Phase. |
|---|---|---|---|
| | $C_6H_5OH$. | $C_6H_6$. | |
| ... | 29.29 | 0 | $C_6H_5OH$ |
| ... | 71.63 | 1.62 | " |
| ... | 74.5 | 3 | $C_6H_5OH+C_6H_6$ |
| 1.0256 | 69.18 | 16.33 | $C_6H_6$ |
| 0.9891 | 55.80 | 36.13 | " |
| 0.9629 | 44.39 | 50.56 | " |
| 0.9142 | 21.15 | 77.22 | " |
| 0.8818 | 4.78 | 94.98 | " |
| 0.8764 | 0 | 99.95 | " |

Data are also given for the solubility of phenol as solid phase, in $C_6H_6$ and in water and in their mixtures. A complete table for the conjugate points, showing the distribution of phenol between the aqueous and the benzene layers, is given. The results agree with those of Rothmund and Wilsmore. See page 385.

The surface tension, density, viscosity and index of refraction of various mixtures of benzene phenol and water whose compositions fall within the completely miscible part of the system, are given by Wiedman and Swearington, 1931.

The following values in substantial accord with those of Horiba, 1914 are by Vondracek and Dostal, 1936. These authors used the synthetic method and from the observed temperatures of appearance of opalescene of known mixtures, values for given temperatures were obtained by graphical interpolation.

Results at 20°

| Gms. per 100 gms. homogeneous mixture | | |
|---|---|---|
| $H_2O$ | $C_6H_6$ | $C_6H_5OH$ |
| 2.61 | 64.71 | 32.68 |
| 4.13 | 54.52 | 41.35 |
| 5.99 | 43.97 | 50.04 |
| 8.92 | 31.49 | 59.59 |
| 13.69 | 17.71 | 68.60 |
| 18.08 | 9.42 | 72.50 |
| 21.98 | 4.64 | 73.38 |

Results at 30°

| Gms. per 100 gms. homogeneous mixture | | |
|---|---|---|
| $H_2O$ | $C_6H_6$ | $C_6H_5OH$ |
| 1.77 | 73.00 | 25.33 |
| 3.77 | 58.51 | 37.72 |
| 5.60 | 47.67 | 46.73 |
| 8.46 | 35.06 | 56.48 |
| 13.22 | 20.57 | 66.21 |
| 17.63 | 11.72 | 70.65 |
| 21.55 | 6.50 | 71.95 |

More recent determinations of the equilibrium in this system at 80° and at 90°, made by the synthetic method, are given by Merclin, 1938.

Solubility of Benzoic Acid in Benzene and Vice Versa. (Roloff, 1895.)

| t°. | Gms. $C_6H_5COOH$ per 100 Gms. Sat. Sol. | Solid Phase. |
|---|---|---|
| 5.37 | 0 | $C_6H_6$ |
| 5 | 1.75 | " |
| 4.50 | 3.95 | " |
| 4.20 | 5 | $C_6H_6+C_6H_5COOH$ |
| 5 | 5.05 | $C_6H_5COOH$ |
| 7 | 5.50 | " |
| 9 | 5.70 | " |
| 11 | 6 | " |
| 20 | 8.8 | $C_6H_5COOH$ |
| 30 | 13 | " |
| 50 | 25 | " |
| 70 | 43.5 | " |
| 90 | 64 | " |
| 110 | 91.5 | " |
| 121 | 100 | " |

Von Euler and Löwenhamn (1916) found 7.6 gms. $C_6H_5COOH$ per 100 cc. of sat. solution in benzene at 18°, and 7.76 gms. $C_6H_5COOH$ + 2.50 gms. $C_6H_4OHCOOH$ *o* per 100 cc. of benzene solution saturated with both acids.

MUTUAL SOLUBILITY OF BENZENE AND β NAPHTHALENE PICRATE, $C_6H_2(NO_2)_3OH.C_{10}H_7OH$. (Kuriloff, 1897.)
Synthetic method used — see Note, p. 292.

| t°. | Gms. Picrate | Gms. Benzene | a | t°. | Gms. Picrate. | Gms. Benzene. | a |
|---|---|---|---|---|---|---|---|
| 157 | 100. | ... | 100.0 | 111.6 | 1.173 | 1.037 | 19.2 |
| 148.4 | 2.128 | 0.115 | 79.3 | 102.0 | 1.087 | 1.780 | 11.2 |
| 137.4 | 1.274 | 0.170 | 61.1 | 29.5 | 0.390 | 8.430 | 0.95 |
| 134.2 | 1.384 | 0.297 | 49.3 | 4.6 | 1.329 | 21.80 | 0.48 |
| 126.8 | 1.019 | 0.343 | 38.3 | 5.02 | ... | 100.0 | ... |

a = Mols. β Naphthalene Picrate per 100 Mols. of β Napthalene Picrate plus Benzene.

Determinations for a large number of isothermes are also given.

Freezing-point data are given for mixtures of Benzene and:

Acetamide(23)
Acetic acid(3)(4)(6)(29)
Acetone(39)
Acetonitrile(20)
Allyl iso sulfocyanide(20)
Aniline(2)(30)
Azoxyanisole(11)
Benzhydrol(10)
Benzil mono oximes(40)
Benzoic acid(3)(36)
Bromo benzene(41)
Bromoform(10)
Bromo nitro benzene(11)
Bromo toluene(15)
Butyro nitrile(20)
Camphene(12)
Carbazole(9)
Carbon disulfide(27)
Carbon tetra chloride (30)(43)(25)
Chloro acetic acid(29)
Chloro benzene(41)
Chloroform(31)(24)(42)
Chloro nitro benzene(11)
Cresol(2)(21)
Cyclohexane(13)
Di cetyl(22)
Di ethyl amine(5)(9)
Di ethyl ether(39)
Di methyl aniline
Di nitro benzenes(1)
Di nitro toluenes(1)
Di phenyl(14)
Di phenyl amine(5)(9)
Ethyl alcohol(24)
Ethyl bromide(25)
Ethyl ether(8)(39)
Ethylene bromide(5)(7)(30)
Ethylene chloride(7)(28)
Formamide(20)
Fluoro benzene(41)
Guaicol(17)
Heptane(46)
Hexane(31)(46)
Hydrobromic acid(44)
Iodo benzene(41)
Menthol(5)
Methyl alcohol(8)
Naphthalene(3)(8)(9)(14)
Naphthol(9)
Nitranilines(12)
Nitro benzene(5)(30)
Nitro benzaldehyde(10)
Nitro benzyl chloride(10)
Nitro methane(20)
Nitro phenols(11)
Nitro toluene(37)(30)
Nitro toluidine(37)
Paraldehyde(15)
Pentane(46)
Phenanthrene(9)
Picryl chloride(26)
Propionitrile(20)
Propyl alcohol(8)
Quinine(18)
Sulfur dioxide(45)
Tetra methyl diamine benzhydrol(10)
Thiophene(19)
Toluene(32)
Toluidine(21)(37)(30)
Tri chloro acetic acid(29)
Tri ethyl amine(20)
Tri nitro benzene(26)
Urethane(16)(34)(35)(38)
Valero nitrile(20)
Xylene(15)(33)
Benzo phenone(47)
Salol(47)

(1) Kremann, 1908; (2) Kremann and Borjanovics, 1916; (3) Roloff, 1895; (4) Dahms, 1893, 1896; (5) Dahms, 1895; (6) Baud, 1912, 1912a; (7) Baud and Gay, 1910, 1911; (8) Pickering, 1893; (9) Bruni, 1898; (10) Schmidlin and Lang, 1912; (11) Bogojawlensky, Winogradow and Bogububow, 1906; (12) Kurnakoff and Efremoff, 1912; (13) Mascarelli and Pestalozza, 1907, 1908; (14) Washburn and Reid, 1915; (15) Paterno and Ampola, 1897; (16) Puschin, Glagoleva and Mazarovich, 1914; (17) Puschin and Rikovski, 1937; (18) Vanlterson-Rotgans, 1913; (19) Tsakalotos and Guye, 1910; (20) Joukovsky, 1934; (21) Glass and Madgin, 1934; (22) Seyer, 1938; (23) Moles and Jimeno, 1913; (24) Wyatt, 1928; (25) Wyatt, 1929; (26) Hammick, Hills and Howard, 1932; (27) Hirshberg, 1932; (28) Huettig and Smyth, 1935; (29) Kendall and Boogė, 1916; (30) Linard, 1925; (31) Timmermans, 1928; (32) Mitsukuri and Nakatsuchi, 1926; (33) Nakatsuchi, 1926; (34) Puschin, 1925; (35) Puschin and Mazarourtsch, 1914; (36) Clupmann, 1918; (37) Dessart, 1926; (38) Puschin, 1929; (39) Yamamura, 1926; (40) Taylor and Marks, 1930; (41) Klemm, Klemm and Schiemann, 1933; (42) Wroczński and Guye, 1910; (43) Lauer and Stodola, 1934; (44) Maass and Russell, 1918; (45) Mazzetti and De Carli, 1926; (46) Ormandy and Craven, 1926; (47) Loskit, 1928.

## BROMO ANILINES o, m and p $BrNH_2$.

Freezing-point data for mixtures of Bromo anilines with Picric acid and with Tri nitro benzene are given by Hertel, 1924. This author also gives results for mixtures of Chloro anilines and Picric acid. Results for mixtures of o Chloro aniline and o Anisidine are given by Aoyama and Morita, 1933.

## *o*, *m* and *p* Chlor**ANILINES**, *o*, *m* and *p* $ClC_6H_4.NH_2$.

### Solubility of Each in Water.

(Sidgwick and Rubie, 1921.)

See Note, p. 580

| Ortho Chloraniline. t°. | Gms. *o* $ClC_6H_4NH_2$ per 100 gms. sat. sol. | Meta Chloraniline. t°. | Gms. *m* $ClC_6H_4NH_2$ per 100 gms. sat. sol. | Para Chloraniline. t°. | Gms. *p* $ClC_6H_4NH_2$ per 100 gms. sat. sol. |
|---|---|---|---|---|---|
| — 2.1.... | 100.0 * | —10.4.... | 100.0 * | 70.5.... | 100.0 * |
| — 7.0.... | 99.8 * (tr. pt.) | —15.0.... | 99.5 * (tr. pt.) | 69.0.... | 99.11 * |
| +19.0.... | 99.44 | — 6.0.... | 99.51 | 67.0.... | 98.41 * |
| 75.0.... | 98.50 | +36.0.... | 98.85 | 65.0.... | 97.5 * (tr. pt.) |
| 115.0.... | 97.58 | 88.0.... | 97.90 | 88.0.... | 96 75 |
| 155.0.... | 96.02 | 130.0.... | 96.50 | 100.0.... | 96.27 |
| 158.0.... | 3 35 | 150.0.... | 2.23 | 145.0.... | 94.28 |
| 130.0.... | 2.19 | 125.0.... | 1.47 | 160.0.... | 4.62 |
| 95.0.... | 1.25 | 100.0.... | 0.91 | 136.0.... | 3.26 |
| 80.0.... | 1.04 | 75.0.... | 0.574 | 111.0.... | 2.20 |
| 71.0.... | 0.916 | | | 55.0.... | 1.04 * |
| | | | | 42.0.... | 0.525* |

* Indicates cases in which a solid phase separated.

### Solubility of *o m* and *p* Chloranilines in Benzene.

(Sidgwick and Rubie, 1921.)

The synthetic method was used. A solid phase separated in each case :

| Ortho Chloraniline. t°. | Gms. *o* $ClC_6H_4NH_2$ per 100 gms. sat. sol. | Solid Phase. | Meta Chloraniline. t°. | Gms. *m* $ClC_6H_4NH_2$ per 100 gms. sat. sol. | Solid Phase. | Para Chloraniline. t°. | Gms. *p* $ClC_6H_4NH_2$ per 100 gms. sat. sol. | Solid Phase. |
|---|---|---|---|---|---|---|---|---|
| — 5.0... | 96.09 | *o* $ClC_6H_4NH_2$ | —10.4... | 93.48 | *m* $ClC_6H_4NH_2$ | 70.0... | 98.90 | *p* $ClC_6H_4NH_2$ |
| — 8.7... | 91.19 | » | —21.0... | 86.18 | » | 60.0... | 85.24 | » |
| —14.4... | 83.13 | » | —25.0... | 80.82 | » | 47.8... | 65.36 | » |
| —23.0... | 72.63 | » | —29.0*.. | 75.5 | »+$C_6H_6$ | 34.8... | 45.47 | » |
| —25.0*.. | 68.5 | »+$C_6H_6$ | —24.4... | 64.33 | $C_6H_6$ | 25.7... | 33.93 | » |
| —21.0... | 57.26 | $C_6H_6$ | —16.2... | 47.02 | » | 14.0... | 21.29 | » |
| —17.4... | 50.86 | » | —14.0... | 43.28 | » | 8.5... | 15.43 | » |
| —12.0... | 39.50 | » | —10.5... | 35.48 | « | 2.4... | 9.42 | » |
| — 6.2.. | 26 46 | » | — 5 0... | 22.68 | » | +1.5*.. | 8.5 | »+$C_6H_6$ |
| — 0.8... | 14.95 | » | — 0.4... | 12.97 | » | 3.4... | 4.66 | $C_6H_6$ |
| + 1.5... | 8.72 | » | + 2.0... | 7.20 | » | 4.2... | 2.87 | » |
| 5.5... | 0.0 | » | 3.5... | 0.0 | » | 5.1... | 0.727 | » |

* Eutec.

### Distribution of o, m and p Chlor Anilines Between Water and Other Solvents at 25°.

(Williams and Soper, 1930.)

| Solvents | Compound | (Range of Concentration Gm. Mols. $C_6H_4ClNH_2$ per liter aq. layer | Distribution Coefficient |
|---|---|---|---|
| Water and Benzene | o Chloroaniline | 0.00115 – 0.00300 | 119 |
| " " " | m " " | 0.00832 – 0.00327 | 86.2 |
| " " " | p " " | 0.00143 – 0.00348 | 62.4 |
| Water and Heptane | p " " | 0.0114 – 0.0142. | 4.31 |

Results are also given for the distribution of p chloro aniline between aqueous potassium chloride and bromide solutions and heptane.

## PHENOL $C_6H_5OH$.

Freezing-Points of Mixtures of Phenol and Water. (Rhodes and Markley, 1921.)

Carefully purified natural phenol was used. To weighed amounts in test tubes of 20 × 3.2 cm., weighed amounts of $H_2O$ were added and the mixtures slowly cooled while being stirred. Near the estimated f. pt. the mixture was seeded by adding a small crystal of solid phenol or of phenol hydrate. "The highest temperature at which permanent crystals could be obtained was taken as the f. pt. of the mixture."

| t°. | Gms. $C_6H_5OH$ per 100 gms. mixture. | Solid Phase. |
|---|---|---|
| 40.8 (m. pt.) | 100.00 | $C_6H_5OH$ |
| 33.0 | 98 | $C_6H_5OH$ + liquid phenol containing 2 $C_6H_5OH$ $H_2O$ in solution. |
| 29.3 | 97 | |
| 23.1 | 95 | |
| 16.2 | 92 | |
| 15.9 | 91.84 | |
| 15.8 (Eutec.) | 91.72 | $C_6H_5OH + 2\,C_6H_5OH.H_2O$ (1) |
| 15.9 | 91.51 | |
| 15.9 (m. pt.) | 91.24 | $2\,C_6H_5OH.H_2O$ |

(1) $2\,C_6H_5OH.H_2O$ in equilibrium with liquid hydrate containing phenol.

| t°. | Gms. $C_6H_5OH$ per 100 gms. mixture. | Solid Phase. |
|---|---|---|
| 15.9 | 91 | $2\,C_6H_5OH.H_2O$ in equilibrium with liquid hydrate containing water. |
| 15.15 | 88 | |
| 13.3 | 82 | |
| 12.4 | 76 * | |
| 12.2 | 73 | |
| 12.2 | 9 | |
| 0.85 (Eutec.) | 5 | $2\,C_6H_5OH.H_2O$ + Ice |
| 0.6 | 3 | Ice |
| 0.45 | 2 | » |
| 0.35 | 0.5 | » |

* Liquid layers separate between these two points.

At concentrations of phenol between 6.5 and 91 per cent there is a metastable equilibrium having two liquid layers and solid phenol in metastable equilibrium with liquid phenol containing water.

| t° | 14°.1. | 6°.2. | 3°.1. | 2°.0. | 1°.7. | 1°.7. | 1°.1. | 0°.6. | 0°.0. | −1°.2 (Eutec.) | −1°.1. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Per cent $C_6H_5OH$. | 91 | 85 | 80 | 77 | 75 | 10 | 9 | 7.5 | 7.0 | 6.5 | 6. |

Additional data on this system are also given by Bailey, 1925.

## PHENOL

Remarks on the experiments of Rhodes and Markley (previous page).

Phenol forms a definite hydrate, $2\ C_6H_5OH.H_2O$ melting at 15°.9 and forming eutectics with anhydrous phenol and with ice, respectively. Because of the tendency towards suspended transformation, the solid phase which ordinarily appears when a mixture of water and phenol is cooled, is the metastable anhydrous phenol. Hydrated crystals were obtained only by seeding with hydrate or by cooling to very low temperatures. Hydrated crystals were originally obtained by cooling a solution of 15 per cent $H_2O$ in phenol for 1 hour to a temperature of —78°. These were used for seeding in order to obtain points on the stable curve. This method avoided supercooling and suspended transformation.

(Approximate data for the f. pt. of mixtures of phenol and water are given by Hoffert, 1922.)

Mutual Solubility of Phenol and Water. (Hill and Malisoff, 1926.)

Highly purified materials were used. The m. pt. of the phenol was 40°.92 ± 0.01. The two bulbed solubility flasks described in *J. Am. Chem. Soc.*, 45, 1143 (1923) were used. At higher temperatures up to the consolute point 66°, the plethostatic method of Alexejeff was used.

| | Phenol Phase | | Water Phase | |
|---|---|---|---|---|
| t. | Wt. % $C_6H_5OH$. | density. | Wt. % $C_6H_5OH$. | density. |
| 20..... | 72.16 | 1.0541 | 8.36 | 1.0018 |
| 25..... | 71.28 | 1.0469 | 8.66 | 1.0045 |
| 30..... | 69.90 | 1.0429 | 9.22 | 1.0039 |
| 35..... | 67.63 | 1.0405 | 9.91 | 0.9974 |
| 54.83..... | 59.22 | — | — | — |
| 57.30..... | — | — | 14.87 | — |
| 59.20..... | 55.76 | — | — | — |
| 62.55..... | 51.87 | — | — | — |
| 62.74..... | — | — | 19.35 | — |
| 65.24..... | 44.09 | — | — | — |
| 65.79..... | — | — | 27.77 | — |
| 66.01..... | — | — | 29.13 | — |
| 65.79..... | — | — | 30.21 | — |
| 65.90..... | — | — | 31.35 | — |
| 65.84..... | — | — | 32.23 | — |
| 65.86..... | — | — | 32.79 | — |
| 65.84..... | 34.23 | — | — | — |

According to Bailey, 1925 the two liquid layers are in contact with solid phenol at 1°.7 and contain respectively 7.6 and 75 wt per cent $C_6H_5OH$. The critical solution temperature is 65.3° and the corresponding phenol content, 36.5 per cent.

A few determinations for the above system are given by Dubrisay, Tripier and Toquet, 1918, 1919.

Several determinations of the mutual solubility of phenol and water at temperatures between 66°.2 and 71°.1 and at pressures up to 1000 kilograms are given by Timmermans, 1922.

The temperature of clouding of various mixtures of phenol and aqueous solutions of sodium hydroxide, barium hydroxide, calcium hydroxide, sulfuric acid, hydrochloric acid, sodium sulfate and sodium chloride were determined by Dubrisay, 1921, 1922, and by Dubrisay, Tripier and Toquet, 1918, 1919. The presence of acids, bases and salts was shown to modify considerably the miscibility of liquid pairs. In general, various mixtures of 0.1 normal aqueous solutions were added to equal volumes of phenol (treated with just enough water to cause it to remain liquid at ordinary temperature) and the temperature of clouding determined. This method was applied to the study of reactions such as the saturation of acids by bases, formation of double sulfates and in general, physical chemical volumetry.

The miscibility of phenol and water as influenced by a third substance, such as azobenzene, anthraquinone, naphthalene, naphthylamine and salol was studied by Boutaric and Nabot, 1923. The results are given in terms of the ratio of the elevation of temperature produced by the addition of the third substance to given mixtures of phenol and water.

## PHENOL $C_6H_5OH$.

### Solubility of Phenol in Water.

(Alexejew, 1886; Schreinemaker, 1900; Rothmund, 1898.)

The determinations were made by the "Synthetic Method," for which, see Note, p. 292.

| t°. | Gms. Phenol per 100 Gms. Aqueous Layer. | Phenol Layer. |
|---|---|---|
| 10 | 7.5 | 75 |
| 20 | 8.3 | 72.1 |
| 30 | 8.8 | 69.8 |
| 40 | 9.6 | 66.9 |
| 50 | 12 | 62.7 |
| 55 | 14.1 | 59.5 |
| 60 | 16.7 | 55.4 |
| 65 | 21.9 | 49.2 |
| 68.3 (crit. temp.) | 33.4 | |

Results confirming the above, and also viscosity measurements, are given by Scarpa (1904).

The complete $T - x$ data for the system are given by Smits and Maarse (1911).

F.-pt. data for the system are given by Rózsa (1911) and Paterno and Ampola (1897).

Vaubel (1895) states that 100 gms. sat. aqueous solution contain 6.1 gms. phenol at 20°. Sp. Gr. of solution = 1.0057.

The following more recent determinations of the complete T-x diagram of the system are given by Campbell and Campbell, 1937. These authors determined the composition of the two layers at temperatures up to 60° by the refractometric method and do not claim an accuracy equal to the results of Hill and Malisoff, 1926.

| t° | Gms. $C_6H_5OH$ per 100 gms. Aqueous layer | Phenol layer | Phases present, Vapor + |
|---|---|---|---|
| -0.3 | 0.9 | — | Ice + solution |
| -0.4 | 1.8 | — | " " |
| -0.7 | 3.3 | — | " " |
| -1.0 | 4.0 | — | " " |
| -1.2 | 5.0 | — | " " |
| -1.3 (Eutec.) | 5.8 | — | " " +$C_6H_5OH$ |
| 0.0 | 6.3 | — | " " " |
| +1.3 (Invar.) | 6.8 | 76.0 | 2 liquids + " |
| 2.6 | 6.9 | 75.6 | " |
| 23.9 | 7.8 | 71.2 | " |
| 29.6 | 7.5 | 70.7 | " |
| 32.5 | 8.0 | 69.0 | " |
| 38.8 | 7.8 | 66.6 | " |
| 45.7 | 9.7 | 64.4 | 2 liquids |
| 50.0 | 11.5 | 62.0 | " |
| 55.5 | 12.0 | 60.0 | " |
| 59.8 | 13.6 | 57.7 | " |
| 60.5 | 14.0 | 55.5 | " |
| 61.8 | 15.0 | 54.0 | " |
| 65.0 | 18.5 | 50.0 | " |
| 66.8 | 34.5 | 34.5 | 1 liquid |
| 4.9 | — | 79.2 | Solution + $C_6H_5OH$ |
| 7.2 | — | 79.8 | " " |
| 10.2 | — | 85.2 | " " |
| 16.1 | — | 87.8 | " " |
| 16.7 | — | 89.1 | " " |
| 19.3 | — | 90.0 | " " |
| 21.9 | — | 91.4 | " " |

These authors also give results for the refractive indices, surface tensions, viscosities, vapor pressures and composition of the vapor phases of the phenol-water system. They also give similar results for the system phenol - 4% aqueous succinic acid.

Additional results for the mutual solubility of Phenol and Water are given by Dolique, 1932 and by Smith, 1931.

The densities of a series of aqueous phenol solutions over the whole range of miscibility at temperatures between 20° and 70° are given by Howell, 1932.

Results showing the influence of various salts upon the Solubility of Water in Phenol at 18° are given by Cernatescu and Papafil, 1927, and Cernatescu, 1928.

The effect of various concentrations of several potassium salts and of malonic and succinic acids upon the solution temperature (65.6°) of an aqueous phenol mixture containing 36 wt. % $C_6H_5OH$ is reported by Culbertson and Palmer, 1931.

Ferguson, 1927, found that the consolute temperature of the system phenol-water was raised from 65.75° to 68.4° by 0.85% o cresol and from 65.75° to 66.5° by 0.8% quinone.

Results for the effect of various concentrations of $HgCl_2$, CuCl and HCl upon the critical solution temperature of the system phenol + water are given by Carter and Megson, 1927.

Results for the effect of increasing amounts of ammonium, potassium and sodium salts upon the temperature of solution of 36.1 percent phenol in water are given by Duckett and Patterson, 1925.

## Equilibrium in the System Phenol and Water at Temperatures Below 13°.

(Jones, 1927.)

The determinations were made to clear up the uncertainties in regard to the hydrate of phenol and the eutectic points of the system.

| t° | Gms. $C_6H_5OH$ per 100 gms. sat. sol. | Solid Phase |
|---|---|---|
| -0.534 | 2.803 | Ice |
| -0.843 Eutec. | 4.607 | "+$(C_6H_5OH)_2.H_2O$ |
| -1.174 Eutec. | 6.839 | "+ $C_6H_5OH$ |
| 0 | 7.005 | $C_6H_5OH$ |
| 0 | 4.695 | $(C_6H_5CH)_2.H_2O$ |
| 4.93 | 5.530 | " |

(1) Under water.

| t° | Gms. $C_6H_5OH$ per 100 gms. sat. sol. | Solid Phase |
|---|---|---|
| 9.93 | 6.771 | $(C_6H_5OH)_2.H_2O$ |
| 12.17 m.pt. | (1) — | "+ Phenol rich liquid layer |
| 1.0 " | (1) — | $C_6H_5OH$+ " |
| 0 | 7.147 | Phenol rich liquid |
| 4.93 | 7.308 | " layer |
| 9.93 | 7.454 | " |
| 13.00 | 7.574 | " |

## Solubility of Phenol at Room Temperature in Ordinary Water and in Heavy Water.

(Nachod, 1938.)

An excess of phenol was shaken with ordinary water and with heavy water and the milky emulsions subjected to centrifugation.

100 gms. sat. solution in ordinary water contained 8.2 gms. $C_6H_5OH$.

100 gms. sat. solution in heavy water contained 6.2 gms. $C_6H_5OH$.

The critical solution temperature of a 35.2 percent solution of phenol in ordinary water ($H_2O$) is 66.45°.

The critical solution temperature of a 35.0 percent solution of phenol in heavy water ($D_2O$) is 78.7°. (Timmermans and Poppe, 1935.)

## PHENOL.

### Solubility of Phenol in Aqueous Acetone Solutions.

(Schreinemakers, 1900.)

| t°. | In 4.24% Acetone. Grams Phenol per 100 Gms. Aq. Acetone Layer. | In 4.24% Acetone. Grams Phenol per 100 Gms. Phenol Layer. | In 12.2% Acetone. Gms. Phenol per 100 Gms. Aq. Acetone Layer. | In 12.2% Acetone. Gms. Phenol per 100 Gms. Phenol Layer. | In 24.6% Acetone. Gms. Phenol per 100 Gms. Aq. Acetone Layer. | In 24.6% Acetone. Gms. Phenol per 100 Gms. Phenol Layer. | In 59.9% Acetone. Gms. Phenol per 100 Gms. Aq. Acetone Layer. | In 59.9% Acetone. Gms. Phenol per 100 Gms. Phenol Layer. |
|---|---|---|---|---|---|---|---|---|
| 20 | ... | ... | ... | ... | ... | ... | 26.0 | 60.5 |
| 30 | 5.0 | 74.0 | 4.0 | 71.0 | 6.0 | 69.5 | 28.5 | 57.0 |
| 40 | 5.5 | 70.0 | ... | ... | ... | ... | 32.0 | 52.0 |
| 50 | 5.7 | 67.0 | 5.0 | 67.0 | 8.0 | 64.0 | 34.5§ | 49.0§ |
| 60 | 6.5 | 61.0 | ... | ... | ... | ... | 36.5‖ | 46.5‖ |
| 70 | 9.0 | 51.0 | 7.5 | 57.5 | 19.0 | 57.0 | (49.5°) | 41.5 |
| 80 | 14.0 | 34.0 | 10.5 | 49.5 | 14.0 | 52.5 | | |
| | (84°) 22.5 | | 20.4* | 30.5* | 23.0† | 47.0† | | |
| | | | (90.3°) 25.0 | | 26.5‡ | 44.0‡ | | |
| | | | | | (90.5°) 35.0 | | | |
| | *90° | | †85° | | ‡87°.5 | §45° | ‖47°.5 | |

The figures in the above table were read from curves plotted from the original results. Similar data are also given for acetone solutions of seven other concentrations.

The determinations were made by adding various quantities of phenol to the mixtures of water and acetone and observing the temperature at which the two layers became homogeneous. The isothermal lines for 30°, 50°, 68°, 80°, 85° and 87° were located. The results for 30° and 80° are as follows: (Schreinemakers, 1900.)

Results at 30°.

| Gms. per 100 Gms. Mixture. $H_2O$. | $(CH_3)_2CO$. | $C_6H_5OH$. |
|---|---|---|
| 92 | 0 | 8 |
| 92.3 | 1.7 | 6 |
| 91 | 4 | 5 |
| 88.4 | 7.6 | 4 |
| 81 | 15 | 4 |
| 70.9 | 23.1 | 6 |
| 62.1 | 28.9 | 9 |
| 51.6 | 34.9 | 13.5 |
| 39.8 | 40.2 | 20 |
| 28.9 | 43.1 | 28 |
| 21.8 | 40.2 | 38 |

| Gms. per 100 Gms. Mixture. $H_2O$. | $(CH_3)_2CO$. | $C_6H_5OH$. |
|---|---|---|
| 18.4 | 34.1 | 47.5 |
| 17.2 | 25.8 | 57 |
| 17.9 | 81.1 | 64 |
| 19.1 | 12.9 | 68 |
| 21.1 | 9.9 | 69 |
| 22.6 | 7.4 | 70 |
| 25.2 | 4.6 | 70.2 |
| 27.1 | 2.3 | 70.6 |
| 28.7 | 1.3 | 70 |
| 30 | 0.5 | 69.5 |

Results at 80°.

| Gms. per 100 Gms. Mixture. $H_2O$. | $(CH_3)_2CO$. | $C_6H_5OH$. |
|---|---|---|
| 83.3 | 3.7 | 13 |
| 82.9 | 7.1 | 10 |
| 74.7 | 13.8 | 11.5 |
| 61.8 | 20.2 | 18 |
| 52.5 | 24.5 | 23 |
| 40.6 | 27.4 | 32 |
| 32.2 | 21.8 | 46 |
| 33.4 | 15.6 | 51 |
| 35.4 | 11.6 | 53 |
| 40.5 | 7.5 | 52 |
| 49.7 | 4.3 | 46 |
| 62.7 | 2.8 | 34.5 |

### Equilibrium in the System Phenol, Benzene and Water at 25°.

(Horiba, 1914–1916.)

| Gms. per 100 Gms. Sat. Sol. $C_6H_5OH$. | $C_6H_6$. | $H_2O$. | Solid Phase. |
|---|---|---|---|
| 81.06 | 18.94 | 0 | $C_6H_5OH$ |
| 89.78 | 7.92 | 2.30 | " |
| 92.31 | 4.07 | 3.62 | " |
| 95.14 | 0 | 4.86 | |

( See following page).

The results for the conjugated liquid layers are as follows:

| Upper Layer. Gms. per 100 Gms. of the Liquid. | | | Lower Layer. Gms. per 100 Gms. of the Liquid. | | |
|---|---|---|---|---|---|
| $C_6H_5OH$. | $C_6H_6$. | $H_2O$. | $C_6H_5OH$. | $C_6H_6$. | $H_2O$. |
| 0 | 99.95 | 0.05 | 0 | 0.198 | 99.802 |
| 4.78 | 94.98 | 0.24 | 1.43 | 0.21 | 98.36 |
| 17.36 | 81.83 | 0.81 | 2.80 | 0.21 | 96.99 |
| 21.15 | 77.22 | 1.63 | 3.01 | 0.21 | 96.77 |
| 28.01 | 69.81 | 2.18 | 3.35 | 0.21 | 96.44 |
| 44.39 | 50.56 | 5.05 | 4.07 | 0.19 | 95.74 |
| 55.80 | 36.13 | 8.07 | 4.58 | 0.19 | 59.23 |
| 74.5 | 3 | 22.5 | 5.65 | 0.17 | 94.18 |
| 70.70 | 0 | 29.29 | 8.195 | 0 | 91.805 |

Data for this system are also given by Rózsa (1911).

The coefficient of distribution of phenol between olive oil and water at 25°, conc. in oil ÷ conc. in $H_2O$, is given by Boeseken and Waterman (1911) as greater than 9 and less than 10.3. The figure was obtained by dividing the solubility of phenol in olive oil by the solubility in water, each being determined separately. Results for this system are also given by Reichel (1909).

According to Greenish and Smith (1903), 100 cc. of olive oil dissolve about 50 gms. of phenol at 15.5°. These authors report that 100 cc. of glycerol dissolve about 300 gms. of phenol at 15.5°.

## Miscibility of Aqueous Alkaline Solutions of Phenol with Several Organic Compounds Insoluble in Water.

(Scheuble, 1907.)

To 5 cc. portions of aq. KOH solution (250 gms. per liter) were added the given amounts of the aq. insoluble compound from a buret and then the phenol, dropwise, until solution occurred. Temperature not stated.

| Composition of Homogeneous Solutions. | | |
|---|---|---|
| cc. Aq. KOH. | cc. Aq. Insol. Cmpd. | Gms. Phenol. |
| 5 | 2 (= 1.64 gms.) Octyl * Alcohol | 2.6 |
| 5 | 5 (= 4.1 gms.) " " | 3.9 |
| 5 | 2 (= 1.74 gms.) Toluene | 4.9 |
| 5 | 3 (= 2.61 gms.) Toluene | 6.7 |
| 5 | 2 (= 1.36 gms.) Heptane | 15 |

* = the normal secondary octyl alcohol, *i. e.*, the so-called capryl alcohol, $CH_3(CH_2)_5.CH(OH)CH_3$.

## Solubility of Phenol in Aqueous Solutions of Dextro Tartaric Acid and of Racemic Acid.

(Schreinemakers, 1900.)

| In 5.093% Acid. Gms. Phenol per 100 Gms. | | | In 19.34% Acid. Gms. Phenol per 100 Gms. | | | In 40.9% Acid. Gms. Phenol per 100 Gms | | |
|---|---|---|---|---|---|---|---|---|
| t°. | Aq. Acid Layer. | Phenol Layer. | t°. | Aq. Acid Layer. | Phenol Layer. | t°. | Aq. Acid. Layer. | Phenol Layer. |
| 30 | 7.5 | 72.5 | 50 | 10 | 77 | 70 | 13 | ... |
| 50 | 10.5 | 65.5 | 60 | 12.5 | 72 | 80 | 16.5 | 77 |
| 60 | 14.5 | 58 | 70 | 19 | 64 | 85 | 20 | 74 |
| 65 | 19.5 | 53 | 75 | 29 | 56 | 90 | 26.5 | 71 |
| 67.5 | 25 | 48.5 | 77* | 47 | | 95 | 39 | 63.5 |
| 69* | 47.5 | | | | | 97* | 54 | |

* Critical temperature.

Identical results were obtained with the dextro and racemic acids, showing that both have exactly the same influence on the formation of layers in the system water-phenol.

Results for equilibrium in the system Phenol + Glycerol + $H_2O$ at 15°, 20°, 30°, 40°, 50° and 60° are given by Dolique, 1932.

### Equilibrium in the System Phenol, Phenyl Hydrazine and Water.

(Ousti-Katchkintzov, 1939.)

| t° homogeneity | Gms. per 100 gms. mixture $C_6H_5NHNH_2$ | $H_2O$ | $C_6H_5OH$ | t° homogeneity | Gms. per 100 gms. mixture $C_6H_5NHNH_2$ | $H_2O$ | $C_6H_5OH$ |
|---|---|---|---|---|---|---|---|
| 72.5 | 10 | 88.2 | 1.8 | 110.3 | 30 | 50.1 | 19.9 |
| 90.2 | 10 | 85.9 | 4.1 | 107.5 | 30 | 39.7 | 30.3 |
| 109.8 | 10 | 80.2 | 9.8 | 98.6 | 30 | 29.8 | 40.2 |
| 112.0 | 10 | 75.0 | 15.0 | 74.7 | 30 | 20.0 | 50.0 |
| 110.0 | 10 | 70.1 | 19.9 | 17.6 | 30 | 8.9 | 61.1 |
| 106.0 | 10 | 64.9 | 25.1 | 72.0 | 40 | 58.2 | 1.8 |
| 102.2 | 10 | 60.3 | 29.7 | 92.8 | 40 | 55.0 | 5.0 |
| 96.1 | 10 | 54.7 | 35.3 | 102.0 | 40 | 50.0 | 10.0 |
| 92.2 | 10 | 50.0 | 40.0 | 105.2 | 40 | 44.8 | 15.2 |
| 76.2 | 10 | 40.0 | 50.0 | 106.4 | 40 | 39.7 | 20.3 |
| 54.9 | 10 | 30.3 | 59.7 | 100.4 | 40 | 30.0 | 30.0 |
| 27.0 | 10 | 20.0 | 70.0 | 77.6 | 40 | 18.9 | 41.1 |
| 58.0 | 20 | 78.7 | 1.3 | 20.2 | 50 | 10.0 | 50.0 |
| 99.8 | 20 | 75.8 | 4.2 | 73.0 | 50 | 47.5 | 2.5 |
| 111.2 | 20 | 70.0 | 10.0 | 86.0 | 50 | 44.0 | 6.0 |
| 112.9 | 20 | 64.8 | 15.2 | 92.8 | 50 | 40.0 | 10.0 |
| 113.0 | 20 | 59.9 | 20.1 | 95.2 | 50 | 34.8 | 15.2 |
| 112.0 | 20 | 55.0 | 25.0 | 92.0 | 50 | 28.9 | 21.1 |
| 108.8 | 20 | 49.7 | 30.3 | 75.0 | 50 | 19.6 | 30.4 |
| 106.5 | 20 | 44.6 | 35.4 | 31.0 | 50 | 12.0 | 38.0 |
| 102.0 | 20 | 40.3 | 39.7 | 74.0 | 60 | 35.2 | 4.8 |
| 82.0 | 20 | 30.0 | 50.0 | 80.2 | 60 | 30.0 | 10.0 |
| 49.1 | 20 | 19.4 | 60.6 | 75.5 | 60 | 25.8 | 14.2 |
| 26.7 | 20 | 16.0 | 64.0 | 54.0 | 60 | 20.3 | 19.7 |
| 74.2 | 30 | 68.8 | 1.2 | 32.0 | 60 | 14.4 | 25.6 |
| 102.0 | 30 | 63.6 | 6.4 | 21.5 | 70 | 26.8 | 3.2 |
| 106.5 | 30 | 60.0 | 10.0 | 23.0 | 70 | 25.0 | 5.0 |
| 108.0 | 30 | 55.9 | 14.1 | 20.4 | 70 | 20.0 | 10.0 |

### Equilibrium in the System Water, Phenol and :

(Hœflake, 1915, 1926.)

Ortho Nitro Phenol.

| Maximum temp. of complete miscibility. | Gms. $o\,C_6H_4.OH.NO_2$ per 100 gms $C_6H_5OH$. |
|---|---|
| 66.45 | 0.0 |
| 69.35 | 0.87 |
| 69.6 | 0.95 |
| 72.15 | 1.70 |
| 76.8 | 3.04 |

Para Nitro Phénol.

| Maximum temp. of complete miscibility. | Gms. $p\,C_6H_4.OH.NO_2$ per 100 gms. $C_6H_5OH$. | Maximum temp. of complete miscibility. | Gms. $p\,C_6H_4.OH.NO_2$ per 100 gms. $C_6H_5OH$. |
|---|---|---|---|
| 66.4 | 0.0 | 68.3 | 17.38 |
| 66.55 | 0.12 | 69.95 | 31.74 |
| 66.8 | 3.65 | 71.65 | 47.4 |
| 67.2 | 7.71 | 74.5 | 79.6 |

The method consisted in adding the amount of water to the several mixtures necessary to give the maximum temperature of complete miscibility.

### Equilibrium in the System Phenol, Pyrocatechol and Water.

(Leone and Angelescu, 1922.)

Synthetic mixtures of weighed amounts of the three components were made and the temperatures of clearing and of clouding of each were determined The mixtures were prepared either by adding increasing amounts of phenol to definite concentrations of aqueous pyrocatechol or of increasing amounts of pyrocatechol to definite concentrations of aqueous phenol. ( Results following page )

## Equilibrium in the System Phenol, Pyrocatechol and Water (Con).

### Results for
Aq. 1.09 wt. % $C_6H_4(OH)_2(o)$

| t°. | Gms. $C_6H_5OH$ per 100 gms. mixture. |
|---|---|
| 27.2.... | 9.14 |
| 38.7.... | 10.44 |
| 47.0.... | 13.02 |
| 57.2.... | 18.55 |
| 59.8.... | 21.99 |
| 61.4.... | 26.80 |
| 63.2.... | 36.09 |
| 62.4.... | 47.46 |
| 60.6.... | 51.62 |
| 56.0.... | 56.84 |
| 44.4.... | 63.47 |
| 29.0.... | 68.67 |
| 17.8.... | 70.80 |

### Results for
Aq. 5.0 wt. % $C_6H_4(OH)_2(o)$.

| t°. | Gms. $C_6H_5OH$ per 100 gms. mixture. |
|---|---|
| 15.4.... | 13.72 |
| 31.0.... | 19.25 |
| 43.6.... | 27.97 |
| 51.4.... | 40.84 |
| 52.2.... | 46.68 |
| 50.6.... | 51.67 |
| 47.4.... | 55.61 |
| 36.0.... | 62.72 |
| 31.0.... | 65.01 |
| 20.4.... | 68.06 |
| 16.2.... | 69.16 |

### Results for
Aq. 9.25 wt. % $C_6H_4(OH)_2(o)$.

| t°. | Gms. $C_6H_5OH$ per 100 gms. mixture. |
|---|---|
| 14.0.... | 27.75 |
| 28.6.... | 35.85 |
| 34.8.... | 41.71 |
| 36.8.... | 50.13 |
| 33.6.... | 55.48 |
| 26.6.... | 60.11 |
| 18.0.... | 64.01 |
| 12.2.... | 65.98 |

Aq. 14.88 wt. % $C_6H_4(OH)_2(o)$.

| | |
|---|---|
| 7.0.... | 42.78 |
| 12.4.... | 49.57 |
| 10.0.... | 55.60 |
| 7.6.... | 57.69 |

### Results for
Aq. 12.5 wt. % $C_6H_5OH$.

| t°. | Gms. $C_6H_4(OH)_2(o)$. per 100 gms. mixture. |
|---|---|
| 52.0.... | 0.0 |
| 49.8.... | 0.42 |
| 44.8.... | 1.05 |
| 39.6.... | 1.65 |
| 34.4.... | 2.16 |
| 17.8.... | 3.65 |

### Results for
Aq. 35.2 wt. % $C_6H_5OH$.

| t°. | Gms. $C_6H_4(OH)_2(o)$. per 100 gms. mixture. |
|---|---|
| 66.6.... | 0.0 |
| 61.8.... | 0.87 |
| 56.0.... | 1.92 |
| 50.8.... | 2.75 |
| 37.4.... | 4.68 |
| 30.8.... | 5.45 |
| 26.2 .... | 6.00 |
| 18.2.... | 6.84 |
| 10.4.... | 7.56 |
| 7.0.... | 7.88 |

### Results for
Aq. 60.7 wt. % $C_6H_5OH$.

| t°. | Gms. $C_6H_4(OH)_2(o)$ per 100 gms. mixture. |
|---|---|
| 53.0.... | 0.0 |
| 48.6.... | 0.79 |
| 48.6.... | 1.70 |
| 37.6.... | 2.64 |
| 33.8.... | 3.27 |
| 23.6.... | 4.67 |
| 13.8.... | 5.88 |

## Isotherms for the System Phenol, Pyrocatechol and Water at 0° and at 10°

(Leone and Angelescu, 1922.)

The determinations were made by titrations using weight pipets.

### Results at 0°.

| Gms. per 100 gms. sat. sol. | | Gms. per 100 gms. sat. sol. | |
|---|---|---|---|
| $C_6H_5OH$. | $C_6H_4(OH)_2(o)$. | $C_6H_5OH$. | $C_6H_4(OH)_2(o)$. |
| 7.23 | 0 0 | 42.29 | 8.97 |
| 10.53 | 3.82 | 44.77 | 8.96 |
| 17.20 | 5.94 | 48.68 | 8.74 |
| 23.05 | 6.95 | 52.71 | 7.96 |
| 26.47 | 7.55 | 59.85 | 6.23 |
| 29.32 | 8.01 | 66.00 | 4.07 |
| 33.98 | 8.55 | 71.46 | 1.69 |
| 37.42 | 8.81 | 75.42 | 0.00 |

### Results at 10°.

| Gms. per 100 gms. sat. sol. | | Gms. per 100 gms. sat. sol. | |
|---|---|---|---|
| $C_6H_5OH$. | $C_6H_4(OH)_2(o)$. | $C_6H_5OH$. | $C_6H_4(OH)_2(o)$. |
| 7.40 | 0.0 | 40.90 | 8.09 |
| 8.44 | 1.67 | 43.25 | 8.08 |
| 10.54 | 3.57 | 46.38 | 7.90 |
| 14.10 | 4.83 | 49.68 | 7.48 |
| 17.50 | 5.63 | 53.00 | 7.00 |
| 20.74 | 6.17 | 57.80 | 5.85 |
| 25.30 | 6.78 | 59.95 | 5.26 |
| 30.09 | 7.44 | 65.32 | 3.49 |
| 33.52 | 7.82 | 73.34 | 0.0 |
| 36.75 | 8.11 | | |

## Equilibrium in the System Phenol, Resorcinol and Water.

(Leone and Angelescu, 1922.)

The determinations were made as in the case of the system phenol, pyrocatechol and water.

Results for Water + $C_6H_5OH$.

| t°. | Gms. $C_6H_5OH$ per 100 gms. mixture. |
|---|---|
| 46.5... | 11.15 |
| 53.5... | 13.17 |
| 58.6... | 15.77 |
| 62.5... | 19.16 |
| 63.8... | 21.36 |
| 65.2... | 25.48 |
| 65.8... | 26.06 |
| 66.6... | 35.43 |
| 65.8... | 37.42 |
| 64.4... | 46.46 |
| 58.8... | 54.98 |
| 54.4... | 54.42 |

Results for Aq. 1.0 wt. % $C_6H_4(OH)_2$ (*m*) + $C_6H_5OH$.

| t°. | Gms. $C_6H_5OH$ per 100 gms. mixture. |
|---|---|
| 38.8... | 11.23 |
| 47.0... | 13.53 |
| 52.2... | 16.00 |
| 58.6... | 22.13 |
| 60.2... | 26.52 |
| 61.6... | 34.87 |
| 61.8... | 40.48 |
| 61.6... | 44.63 |
| 59.8... | 50.66 |
| 58.8... | 52.49 |
| 53.0... | 57.97 |
| 49.0... | 60.58 |
| 42.4... | 63.70 |
| 34.0... | 66.51 |

Results for Aq. 2.91 wt. % $C_6H_4(OH)_2$ (*m*) + $C_6H_5OH$.

| t°. | Gms. $C_6H_5OH$ per 100 gms. mixture. |
|---|---|
| 25.4... | 12.17 |
| 41.0... | 17.34 |
| 47.4... | 22.75 |
| 51.0... | 28.63 |
| 53.8... | 35.40 |
| 54.6... | 39.10 |
| 55.0... | 41.58 |
| 55.4... | 44.97 |
| 55.0... | 47.16 |
| 54.6... | 49.15 |
| 53.8... | 50.98 |
| 51.4... | 54.07 |
| 46.0... | 58.70 |
| 32.6... | 65.40 |

Results for Aq. 4.76 wt. % $C_6H_4(OH)_2$ (*m*) + $C_6H_5OH$.

| t°. | Gms. $C_6H_5OH$ per 100 gms. mixture. |
|---|---|
| 22.0... | 16.47 |
| 35.6... | 23.47 |
| 41.8... | 31.33 |
| 46.0... | 38.95 |
| 47.6... | 43.67 |
| 47.8... | 45.94 |
| 47.6... | 48.60 |
| 45.0... | 54.05 |
| 40.2... | 58.57 |
| 31.0... | 63.45 |
| 19.8... | 67.48 |

Aq. 9.09 wt. % $C_6H_4(OH)_2$ (*m*) + $C_6H_5OH$.

| t°. | Gms. $C_6H_5OH$ per 100 gms. mixture. |
|---|---|
| 18.6... | 38.20 |
| 24.0... | 42.00 |
| 26.4... | 45.51 |
| 27.6... | 49.80 |
| 27.2... | 52.58 |
| 25.7... | 55.03 |
| 22.0... | 57.04 |
| 16.1... | 61.95 |

Aq. 13.01 wt. % $C_6H_5OH$ + $C_6H_4(OH)_2$ (*m*).

| t°. | Gms. $C_6H_4(OH)_2$ (*m*) per 100 gms. mixture. |
|---|---|
| 54.0... | 0.0 |
| 51.6... | 0.29 |
| 48.8... | 0.60 |
| 47.2... | 0.78 |
| 43.8... | 1.14 |
| 39.8... | 1.56 |
| 35.7... | 1.94 |
| 31.8... | 2.29 |
| 24.8... | 2.89 |
| 20.2... | 3.26 |
| 17.4... | 3.43 |

Aq. 35.81 % $C_6H_5OH$ + $C_6H_4(OH)_2$ (*m*)

| t°. | Gms. $C_6H_4(OH)_2$ (*m*) per 100 gms. mixture. |
|---|---|
| 66.4... | 0.0 |
| 65.4... | 0.17 |
| 62.0... | 0.66 |
| 59.2... | 1.11 |
| 54.6... | 1.79 |
| 49.4... | 2.50 |
| 44.4... | 3.13 |
| 41.8... | 3.43 |
| 31.0... | 4.62 |
| 24.0... | 5.32 |
| 17.5... | 5.88 |

Aq. 61.83 % $C_6H_5OH$ + $C_6H_4(OH)_2$ (*m*).

| t°. | Gms. $C_6H_4(OH)_2$ (*m*) per 100 gms. mixture. |
|---|---|
| 51.1... | 0.0 |
| 49.4... | 0.25 |
| 37.6... | 1.83 |
| 37.4... | 1.98 |
| 28.4... | 2.99 |
| 24.8... | 3.37 |
| 21.4... | 3.77 |
| 15.2... | 4.38 |

## Isotherms for the System Phenol, Resorcinol and Water.

Results at 0°.

| Gms. per 100 gms. sat. sol. | |
|---|---|
| $C_6H_5OH$. | $C_6H_4(OH)_2$ (*m*). |
| 7.23 | 0.0 |
| 8.11 | 1.72 |
| 9.19 | 2.43 |
| 10.07 | 3.11 |
| 13.62 | 4.81 |
| 19.41 | 5.98 |
| 24.12 | 6.57 |
| 27.65 | 6.74 |
| 32.98 | 7.16 |
| 36.23 | 7.33 |
| 40.91 | 7.36 |
| 45.03 | 7.42 |

| Gms. per 100 gms. sat. sol. | |
|---|---|
| $C_6H_5OH$. | $C_6H_4(OH)_2$ (*m*). |
| 40.03 | 7.45 |
| 43.12 | 7.50 |
| 47.88 | 7.29 |
| 50.67 | 7.03 |
| 53.98 | 6.73 |
| 56.72 | 6.12 |
| 59.12 | 5.60 |
| 62.67 | 4.68 |
| 66.78 | 3.37 |
| 70.50 | 2.01 |
| 72.57 | 1.22 |
| 75.42 | 0.0 |

Results at 10°.

| Gms. per 100 gms. sat. sol. | |
|---|---|
| $C_6H_5OH$. | $C_6H_4(OH)_2$ (*m*). |
| 7.40 | 0.0 |
| 8.44 | 1.71 |
| 9.75 | 2.41 |
| 10.95 | 3.07 |
| 13.71 | 4.19 |
| 15.75 | 4.69 |
| 23.19 | 5.69 |
| 28.71 | 6.17 |
| 31.04 | 6.37 |
| 32.81 | 6.42 |
| 38.31 | 6.59 |
| 45.04 | 6.59 |

| Gms. per 100 gms. sat. sol. | |
|---|---|
| $C_6H_5OH$. | $C_6H_4(OH)_2$ (*m*). |
| 43.30 | 6.59 |
| 44.39 | 6.58 |
| 45.23 | 6.49 |
| 48.54 | 6.24 |
| 50.66 | 6.19 |
| 54.15 | 5.62 |
| 61.37 | 4.09 |
| 64.33 | 3.26 |
| 67.86 | 2.09 |
| 70.64 | 1.14 |
| 72.36 | 0.30 |
| 73.34 | 0.0 |

The preceeding results by Leone and Angelescu are presented in part by Angelescu, 1928a, in connection with calculations of solubilities in these systems.

## Equilibrium in the System Phenol, Salicylic Acid and Water.

(Bailey, 1925.)

The synthetic method was employed. Varying amounts of salicylic acid were added to known mixtures of phenol and water and placed in sealed tubes. The temperature of *sudden thickening* was determined. This point was considered as a more accurate indication of the saturation temperature than the mean between the temperature of clouding and clearing. This was found especially true at the higher temperatures. No compounds or mixed crystals were found at any temperature.

### The Binary and Ternary Equilibrium End Points are as Follows :

| t°. | Gms. per 100 gms. of mixture. $C_6H_5OH$. | $C_6H_4OH.COOH(o)$. | $H_2O$. | Solid Phase. |
|---|---|---|---|---|
| −0.07.. | 0.0 | 0.103 | 99.9 | $C_6H_4OH.COOH(o)+H_2O$ (Eutectic) |
| −1.2... | 6.5 | 0.00 | 93.5 | $C_6H_5OH$ $+H_2O$ » |
| 38.16.. | 95.0 | 5.0 | 0.0 | $C_6H_4OH.COOH(o)+C_6H_5OH$ » |
| 1.7... | 7.6 | 0.0 | 92.4 | $C_6H_5OH$ + 2 liquid layers |
| 1.7... | 75.0 | 0.0 | 25.0 | » + 2 » » |
| 65.3... | 36.5 | 0.0 | 63.5 | Critical solution temperature for phenol + water |
| 87.0... | 0.0 | 30.0 | 70.0* | » » » » salicylic ac. + » |
| −1.3... | 6.5 | 0.2 | 93.3 | $C_6H_4OH.COOH(o)+C_6H_5OH+H_2O$ (Eutectic |
| 61.2... | 20.4 | 7.6 | 72.0 | Point where two binodal surfaces touch |
| 63.4... | 21.7 | 12.7 | 65.6 | $C_6H_4OH.COOH(o)$ + liquid layers |
| −0.6... | 6.6 | 0.2 | 93.2 | $C_6H_4OH.COOH(o)+C_6H_4OH$ + two liquid layers |
| −0.6... | 69.6 | 4.2 | 25.9 | |

* Indicates unstable equilibrium.

### Results for the Isotherm at 25°:

The mixtures were stirred in a thermostat and equilibrium approached from above and from below

| $d_{25}^{25}$ of sat. sol. | Gms. per 100 gms. sat. sol. $C_6H_5OH$. | $C_6H_4OH$ $COOH(o)$ | Solid Phase. |
|---|---|---|---|
| 1.0008 | 0.0 | 0.22 | $C_6H_4OH.COOH(o)$ |
| 1.0032 | 2.42 | 0.28 | » |
| 1.0057 | 5.05 | 0.40 | » |
| 1.0080 | 7.51 | 0.53 | » + $L_1$+$L_2$ |
| 1.0064 | 59.07 | 8.77 | |
| 1.0700 | 62.66 | 8.96 | $C_6H_4OH.COOH(o)$ |
| 1.0761 | 83.00 | 6.32 | » |
| 1.0785 | 90.74 | 4.60 | » + $C_6H_5OH$ |
| 1.0793 | 93.10 | 2.49 | $C_6H_5OH$ |
| 1.0803 | 95.70 | 0.0 | » |

| $d_{25}^{25}$ of sat. sol. | Gms. per 100 gms. sat. sol. $C_6H_5OH$. | $C_6H_4OH$ $COOH(o)$. | Solid Phase |
|---|---|---|---|
| 1.0470 | 70.19 | 0.0 | $L_1 + L_2$ |
| 1.0070 | 8.43 | 0.0 | |
| 1.050 | 69.28 | 0.51 | $L_1 + L_2$ |
| 1.0072 | 8.35 | 0.04 | |
| 1.0529 | 67.41 | 1.81 | $L_1 + L_2$ |
| 1.0074 | 8.23 | 0.13 | |
| 1.0544 | 65.79 | 3.12 | $L_1 + L_2$ |
| 1.0075 | 8.14 | 0.21 | |
| 1.0610 | 60.8 | 7.56 | $L_1 + L_2$ |
| 1.0078 | 7.66 | 0.46 | |

$L_1$ = liquid layer rich in phenol (low in salicylic acid)
$L_2$ = » » » » water ( » » » » ).

Results similar to the above are given for 30°, 44°, 58°, 61°, 63° and 68°.8.

### Freezing-Points of Mixtures of Phenol and Salicylic Acid

(Bailey, 1925.)

| t° of f. pt. | Gms. $C_6H_5OH$ per 100 gms. mixture. | t° of f. pt. | Gms. $C_6H_5OH$ per 100 gms. mixture. | t° of f. pt. | Gms. $C_6H_5OH$ per 100 gms. mixtur |
|---|---|---|---|---|---|
| 40.8..... | 100.0 | 45.9..... | 92.62 | 128.7..... | 40.0 |
| 39.95..... | 92.36 | 55.6..... | 89.91 | 147.2..... | 18.2 |
| 39.12..... | 96.83 | 65.6..... | 85.8 | 157.0..... | 5.1 |
| 38.47..... | 95.61 | 89.2..... | 72.5 | 160.4..... | 0.0 |
| 38.16 (Eutec.). | 95.0 | 113.5..... | 54.0 | | |

## Equilibrium in the System Phenol, Resorcinol and Water.

(Leone and Angelescu, 1922.)

The determinations were made as in the case of the system phenol, pyrocatechol and water.

Results for Water + $C_6H_5OH$.

| t°. | Gms. $C_6H_5OH$ per 100 gms. mixture. |
|---|---|
| 46.5... | 11.15 |
| 53.5... | 13.17 |
| 58.6... | 15.77 |
| 62.5... | 19.16 |
| 63.8... | 21.36 |
| 65.2... | 25.48 |
| 65.8... | 26.06 |
| 66.6... | 35.43 |
| 65.8... | 37.42 |
| 64.4... | 46.46 |
| 58.8... | 54.98 |
| 54.4... | 54.42 |

Results for Aq. 1.0 wt. % $C_6H_4(OH)_2$ (*m*) + $C_6H_5OH$.

| t°. | Gms. $C_6H_5OH$ per 100 gms. mixture. |
|---|---|
| 38.8... | 11.23 |
| 47.0... | 13.53 |
| 52.2... | 16.00 |
| 58.6... | 22.13 |
| 60.2... | 26.52 |
| 61.6... | 34.87 |
| 61.8... | 40.48 |
| 61.6... | 44.63 |
| 59.8... | 50.66 |
| 58.8... | 52.49 |
| 53.0... | 57.97 |
| 49.0... | 60.58 |
| 42.4... | 63.70 |
| 34.0... | 66.51 |

Results for Aq. 2.91 wt. % $C_6H_4(OH)_2$ (*m*) + $C_6H_5OH$.

| t°. | Gms. $C_6H_5OH$ per 100 gms. mixture. |
|---|---|
| 25.4... | 12.17 |
| 41.0... | 17.34 |
| 47.4... | 22.75 |
| 51.0... | 28.63 |
| 53.8... | 35.40 |
| 54.6... | 39.10 |
| 55.0... | 41.58 |
| 55.4... | 44.97 |
| 55.0... | 47.16 |
| 54.6... | 49.15 |
| 53.8... | 50.98 |
| 51.4... | 54.07 |
| 46.0... | 58.70 |
| 32.6... | 65.40 |

Results for Aq. 4.76 wt. % $C_6H_4(OH)_2$ (*m*) + $C_6H_5OH$.

| t°. | Gms. $C_6H_5OH$ per 100 gms. mixture. |
|---|---|
| 22.0... | 16.47 |
| 35.6... | 23.47 |
| 41.8... | 31.33 |
| 46.0... | 38.95 |
| 47.6... | 43.67 |
| 47.8... | 45.94 |
| 47.6... | 48.60 |
| 45.0... | 54.05 |
| 40.2... | 58.57 |
| 31.0... | 63.45 |
| 19.8... | 67.48 |

Aq. 9.09 wt. % $C_6H_4(OH)_2$ (*m*) + $C_6H_5OH$.

| t°. | Gms. $C_6H_5OH$ per 100 gms. mixture. |
|---|---|
| 18.6... | 38.20 |
| 24.0... | 42.00 |
| 26.4... | 45.51 |
| 27.6... | 49.80 |
| 27.2... | 52.58 |
| 25.7... | 55.03 |
| 22.0... | 57.04 |
| 16.1... | 61.95 |

Aq. 13.04 wt. % $C_6H_5OH$ + $C_6H_4(OH)_2$ (*m*).

| t°. | Gms. $C_6H_4(OH)_2$ (*m*) per 100 gms. mixture. |
|---|---|
| 54.0... | 0.0 |
| 51.6... | 0.29 |
| 48.8... | 0.60 |
| 47.2... | 0.78 |
| 43.8... | 1.14 |
| 39.8... | 1.56 |
| 35.7... | 1.94 |
| 31.8... | 2.29 |
| 24.8... | 2.89 |
| 20.2... | 3.26 |
| 17.4... | 3.43 |

Aq. 35.81 % $C_6H_5OH$ + $C_6H_4(OH)_2$ (*m*)

| t°. | Gms. $C_6H_4(OH)_2$ (*m*) per 100 gms. mixture. |
|---|---|
| 66.4... | 0.0 |
| 65.4... | 0.17 |
| 62.0... | 0.66 |
| 59.2... | 1.11 |
| 54.6... | 1.79 |
| 49.4... | 2.50 |
| 44.4... | 3.13 |
| 41.8... | 3.43 |
| 31.0... | 4.62 |
| 24.0... | 5.32 |
| 17.5... | 5.88 |

Aq. 61.83 % $C_6H_5OH$ + $C_6H_4(OH)_2$ (*m*).

| t°. | Gms. $C_6H_4(OH)_2$ (*m*) per 100 gms. mixture. |
|---|---|
| 51.1... | 0.0 |
| 49.4... | 0.25 |
| 37.6... | 1.83 |
| 37.4... | 1.98 |
| 28.4... | 2.99 |
| 24.8... | 3.37 |
| 21.4... | 3.77 |
| 15.2... | 4.38 |

## Isotherms for the System Phenol, Resorcinol and Water.

### Results at 0°.

| Gms. per 100 gms. sat. sol. | |
|---|---|
| $C_6H_5OH$. | $C_6H_4(OH)_2$ (*m*). |
| 7.23 | 0.0 |
| 8.11 | 1.72 |
| 9.19 | 2.43 |
| 10.07 | 3.11 |
| 13.62 | 4.81 |
| 19.41 | 5.98 |
| 24.12 | 6.57 |
| 27.65 | 6.74 |
| 32.98 | 7.16 |
| 36.23 | 7.33 |
| 40.91 | 7.36 |
| 45.03 | 7.42 |

| Gms. per 100 gms. sat. sol. | |
|---|---|
| $C_6H_5OH$. | $C_6H_4(OH)_2$ (*m*). |
| 40.03 | 7.45 |
| 43.12 | 7.50 |
| 47.88 | 7.29 |
| 50.67 | 7.03 |
| 53.98 | 6.73 |
| 56.72 | 6.12 |
| 59.12 | 5.60 |
| 62.67 | 4.68 |
| 66.78 | 3.37 |
| 70.50 | 2.01 |
| 72.57 | 1.22 |
| 75.42 | 0.0 |

### Results at 10°.

| Gms. per 100 gms. sat. sol. | |
|---|---|
| $C_6H_5OH$. | $C_6H_4(OH)_2$ (*m*). |
| 7.40 | 0.0 |
| 8.44 | 1.71 |
| 9.75 | 2.41 |
| 10.95 | 3.07 |
| 13.71 | 4.19 |
| 15.75 | 4.69 |
| 23.19 | 5.69 |
| 28.71 | 6.17 |
| 31.04 | 6.37 |
| 32.81 | 6.42 |
| 38.31 | 6.59 |
| 45.04 | 6.59 |

| Gms. per 100 gms. sat. sol. | |
|---|---|
| $C_6H_5OH$. | $C_6H_4(OH)_2$ (*m*). |
| 43.30 | 6.59 |
| 44.39 | 6.58 |
| 45.23 | 6.49 |
| 48.54 | 6.24 |
| 50.66 | 6.19 |
| 54.15 | 5.62 |
| 61.37 | 4.09 |
| 64.33 | 3.26 |
| 67.86 | 2.09 |
| 70.64 | 1.14 |
| 72.36 | 0.30 |
| 73.34 | 0.0 |

The preceeding results by Leone and Angelescu are presented in part by Angelescu, 1928a, in connection with calculations of solubilities in these systems.

### Equilibrium in the System Phenol, Salicylic Acid and Water.

(Bailey, 1925.)

The synthetic method was employed. Varying amounts of salicylic acid were added to known mixtures of phenol and water and placed in sealed tubes. The temperature of *sudden thickening* was determined. This point was considered as a more accurate indication of the saturation temperature than the mean between the temperature of clouding and clearing. This was found especially true at the higher temperatures. No compounds or mixed crystals were found at any temperature.

The Binary and Ternary Equilibrium End Points are as Follows :

| t°. | Gms. per 100 gms. of mixture. $C_6H_5OH$. | $C_6H_4OH.COOH(o)$. | $H_2O$. | Solid Phase. |
|---|---|---|---|---|
| −0.07.. | 0.0 | 0.103 | 99.9 | $C_6H_4OH.COOH(o)+H_2O$ (Eutectic) |
| −1.2... | 6.5 | 0.00 | 93.5 | $C_6H_5OH$ $+H_2O$ » |
| 38.16.. | 95.0 | 5.0 | 0.0 | $C_6H_4OH.COOH(o)+C_6H_5OH$ » |
| 1.7... | 7.6 | 0.0 | 92.4 | $C_6H_5OH$ + 2 liquid layers |
| 1.7... | 75.0 | 0.0 | 25.0 | » +2 » » |
| 65.3... | 36.5 | 0.0 | 63.5 | Critical solution temperature for phenol + water |
| 87.0... | 0.0 | 30.0 | 70.0* | » » » » salicylic ac. + » |
| −1.3... | 6.5 | 0.2 | 93.3 | $C_6H_4OH.COOH(o)+C_6H_5OH+H_2O$ (Eutectic |
| 61.2... | 20.4 | 7.6 | 72.0 | Point where two binodal surfaces touch |
| 63.4... | 21.7 | 12.7 | 65.6 | $C_6H_4OH.COOH(o)$ + liquid layers |
| −0.6... | 6.6 | 0.2 | 93.2 | $C_6H_4OH.COOH(o)+C_6H_4OH$ + two liquid layers |
| −0.6... | 69.6 | 4.2 | 25.9 | |

* Indicates unstable equilibrium.

### Results for the Isotherm at 25°:

The mixtures were stirred in a thermostat and equilibrium approached from above and from below

| $d_{\frac{25}{25}}$ of sat. sol. | Gms. per 100 gms. sat. sol. $C_6H_5OH$. | $C_6H_4OH$ $COOH(o)$ | Solid Phase. |
|---|---|---|---|
| 1.0098 | 0.0 | 0.22 | $C_6H_4OH.COOH(o)$ |
| 1.0032 | 2.42 | 0.28 | » |
| 1.0057 | 5.05 | 0.40 | » |
| 1.0080 | 7.51 | 0.53 | » + $L_1$+$L_2$ |
| 1.0064 | 59.07 | 8.77 | |
| 1.0700 | 62.66 | 8.96 | $C_6H_4OH.COOH(o)$ |
| 1.0761 | 83.00 | 6.32 | » |
| 1.0785 | 90.74 | 4.60 | » + $C_6H_5OH$ |
| 1.0793 | 93.10 | 2.49 | $C_6H_5OH$ |
| 1.0803 | 95.70 | 0.0 | » |

| $d_{\frac{25}{25}}$ of sat. sol. | Gms. per 100 gms. sat. sol $C_6H_5OH$. | $C_6H_4OH$ $COOH(o)$. | Solid Phase |
|---|---|---|---|
| 1.0470 | 70.19 | 0.0 | $L_1 + L_2$ |
| 1.0070 | 8.43 | 0.0 | |
| 1.050 | 69.28 | 0.51 | $L_1 + L_2$ |
| 1.0072 | 8.35 | 0.04 | |
| 1.0529 | 67.41 | 1.81 | $L_1 + L_2$ |
| 1.0074 | 8.23 | 0.13 | |
| 1.0544 | 65.79 | 3.12 | $L_1 + L_2$ |
| 1.0075 | 8.14 | 0.21 | |
| 1.0610 | 60.8 | 7.56 | $L_1 + L_2$ |
| 1.0078 | 7.66 | 0.46 | |

$L_1$ = liquid layer rich in phenol (low in salicylic acid)
$L_2$ = » » » » water ( » » » » ).

Results similar to the above are given for 30°, 44°, 58°, 61°, 63° and 68°.8.

### Freezing-Points of Mixtures of Phenol and Salicylic Acid

(Bailey, 1925.)

| t° of f. pt. | Gms. $C_6H_5OH$ per 100 gms. mixture. | t° of f. pt. | Gms. $C_6H_5OH$ per 100 gms. mixture. | t° of f. pt. | Gms. $C_6H_5OH$ per 100 gms. mixtur |
|---|---|---|---|---|---|
| 40.8..... | 100.0 | 45.9..... | 92.62 | 128.7..... | 40.0 |
| 39.95..... | 92.36 | 55.6..... | 89.91 | 147.2..... | 18.2 |
| 39.12..... | 96.83 | 65.6..... | 85.8 | 157.0..... | 5.1 |
| 38.47..... | 95.61 | 89.2..... | 72.5 | 160.4..... | 0.0 |
| 38.16(Eutec.). | 95.0 | 113.5..... | 54.0 | | |

## Equilibrium in the System Phenol, Salicylic Acid and Water

(Bailey, 1925.)

The following data for the binodal curves were obtained by the synthetic method. The author determined for each mixture the temperature of the beginning of critical opalescence (C. op.) and the critical solution temperature (C.S.T.). S = gms. $C_6H_4OH.COOH$ (*o*) per 100 gms. sat. solution.

### Results for Aqueous Phenol of :

9.2 % $C_6H_5OH$.

| C. S. T. | C. op. | S. |
|---|---|---|
| 32.9 | 32.9 | 0.0 |
| 58.0 | 58.0 | 5.8* |
| 61.0 | 61.0 | 6.8* |
| 63.0 | 63.0 | 7.7* |
| 68.8 | 69.5 | 11.7* |
| 79.0 | 83.5 | 35.4* |
| 79.0 | 79.5 | 45.5* |
| 68.8 | 68.8 | 58.5* |
| 58.0 | 58.0 | 65.4* |

14.6 % $C_6H_5OH$.

| C. S. T. | C. op. | S. |
|---|---|---|
| 56.6 | 56.8 | 0.0 |
| 58.0 | 59.0 | 3.5 |
| 61.0 | 62.0 | 5.9 |
| 61.0 | 62.5 | 6.5 |
| 61.0 | 63.0 | 7.2* |
| 63.0 | 65.0 | 9.0* |
| 68.8 | 71.0 | 15.8* |
| 68.8 | 69.0 | 53.4* |
| 58.0 | 58.0 | 61.3* |

17.0 % $C_6H_5OH$.

| C. S. T. | C. op. | S. |
|---|---|---|
| 59.7 | 60.0 | 0.0 |
| 61.0 | 64.0 | 6.5 |
| 63.0 | 65.0 | 8.8 |
| 68.8 | 73.0 | 21.5* |
| 68.0 | 69.0 | 49.5* |
| 63.0 | 63.0 | 57.0* |
| 58.0 | 58.0 | 58.0* |

20.6 % $C_6H_5OH$.

| C. S. T. | C. op. | S |
|---|---|---|
| 62.0 | 63.2 | 0.0 |
| 61.0 | 63.5 | 5.2 |
| 61.0 | 64.0 | 5.6 |
| 63.0 | 68.0 | 10.8 |
| 68.8 | 72.2 | 28.0* |
| 68.8 | 68.8 | 45.3* |
| 63.0 | 63.0 | 53.3* |
| 58.0 | 58.0 | 54.7* |

25.0 % $C_6H_5OH$.

| C. S. T. | C. op. | S. |
|---|---|---|
| 63.4 | 65.8 | 0.0 |
| 63.0 | 65.0 | 1.3 |
| 63.0 | 71.5 | 12.6 |
| 63.0 | 63.0 | 45.6* |
| 58.0 | 58.0 | 49.3* |

29.9 % $C_6H_5OH$.

| C. S. T. | C. op. | S. |
|---|---|---|
| 64.6 | 67.0 | 0.0 |
| 63.0 | 66.0 | 2.2 |
| 61.0 | 69.0 | 8.3 |
| 61.0 | 70.0 | 11.2 |
| 63.5 | 73.0 | 21.0 |
| 61.0 | 61.0 | 39.2* |
| 58.0 | 58.0 | 42.4* |

31.9 % $C_6H_5OH$.

| C. S. T. | C. op. | S. |
|---|---|---|
| 65.3 | 67.3 | 0.0 |
| 63.0 | 68.0 | 2.3 |
| 61.0 | 64.5 | 8.1 |
| 61.0 | 62.0 | 16.0 |
| 61.0 | 61.0 | 22.5* |
| 58.0 | 58.0 | 32.6* |

41.7 % $C_6H_5OH$.

| C. S. T. | C. op. | S. |
|---|---|---|
| 65.0 | 68.3 | 0.0 |
| 63.0 | 66.0 | 2.3 |
| 6.01 | 64.0 | 4.8 |
| 58.0 | 58.0 | 13.3 |

* estable points.

50.8 % $C_6H_5OH$.

| C. S. T. | C. op. | S. |
|---|---|---|
| 62.2 | 64.4 | 0.0 |
| 61.0 | 63.0 | 1.6 |
| 58.0 | 59.0 | 4.1 |

## Solubility of Phenol in Liquid Paraffin.

A series of mixtures of phenol and liquid paraffin were prepared by rubbing and warming They were then kept at 15° for 24 hours. A small amount of phenol separated from the mixture containing 2.0 per cent $C_6H_5OH$ but none from that containing 1.0 per cent. The solubility of phenol in liquid paraffin was, therefore, considered to be between 1 and 2 per cent at 15°.

(Gofman-Nicoresti, 1922.)

## Equilibrium in the System Phenol, Thymol and Water.

(Wilcox and Bailey, 1929.)

The synthetic method was used and from the curves plotted from the results the values for the following isotherms were obtained.

| t° | Gms. per 100 gms. homogeneous mixture | |
|---|---|---|
| | $C_6H_5OH$ | $C_{10}H_{13}OH$ |
| 15 | 73.1 | 0.0 |
| " | 70.0 | 1.0 |
| " | 71.0 | 2.0 |
| " | 70.2 | 9.5 |
| " | 15.9 | 80.3 |
| " | 2.3 | 94.0 |
| " | 0.6 | 95.2 |
| " | 0.0 | 95.6 |
| 65 | 0.0 | 0.1 |
| " | 10.9 | 0.1 |
| " | 19.8 | 0.1 |
| " | 32.2 | 0.0 |
| " | 42.0 | 0.0 |

| t° | Gms. per 100 gms. homogeneous mixture | |
|---|---|---|
| | $C_6H_5OH$ | $C_{10}H_{13}OH$ |
| 65 | 49.2 | 0.8 |
| " | 50.2 | 0.5 |
| " | 59.2 | 3.3 |
| " | 61.0 | 6.0 |
| " | 59.5 | 18.5 |
| " | 41.0 | 47.0 |
| " | 34.5 | 55.0 |
| " | 19.4 | 73.1 |
| " | 2.4 | 93.0 |
| " | 0.5 | 94.5 |
| " | 0.0 | 95.0 |

| t° | Gms. per 100 gms. homogeneous mixture | |
|---|---|---|
| | $C_6H_5OH$ | $C_{10}H_{13}OH$ |
| 200 | 0.0 | 10.0 |
| " | 4.8 | 4.0 |
| " | 18.0 | 9.1 |
| " | 26.1 | 18.2 |
| " | 8.1 | 75.8 |
| " | 1.0 | 87.0 |
| " | 0.0 | 75.1 |
| 250 | 0.0 | 71.5 |
| " | 6.7 | 67.3 |
| " | 14.5 | 55.0 |
| " | 19.3 | 40.0 |
| " | 15.9 | 20.1 |
| " | 4.9 | 8.9 |
| " | 0.0 | 19.0 |

## Distribution of Phenol between Water and Benzene and between Aqueous $K_2SO_4$ Solutions and Benzene at 25°.

(Rothmund and Wilsmore — Z. physik. Ch. 40, 623, '02)

Note. — The original results, which are given in terms of gram mols. per liter, were calculated to grams per liter, and plotted on cross-section paper. The following figures were read from the curves obtained.

| Between $H_2O$ and $C_6H_6$. | | Effect of $K_2SO_4$ upon the Distribution. | | | | |
|---|---|---|---|---|---|---|
| Grams $C_6H_5OH$ per Liter of: | | Gms. $K_2SO_4$ per Liter Aq. Solution. | (1) Gms. $C_6H_5OH$ per Liter of: | | (2) Gms. $C_6H_5OH$ per Liter of: | |
| $H_2O$ Layer. | $C_6H_6$ Layer. | | Aq. Layer. | $C_6H_6$ Layer. | Aq. Layer. | $C_6H_6$ Layer. |
| 5 | 10 | 1.36 | 17.08 | 59.96 | 9.52 | 26.28 |
| 10 | 28 | 2.72 | 16.92 | 60.63 | 9.50 | 26.38 |
| 15 | 52 | 5.44 | 16.85 | 60.92 | 9.46 | 26.55 |
| 20 | 84 | 10.89 | 16.44 | 62.73 | 9.35 | 27.06 |
| 25 | 128 | 21.79 | 15.89 | 65.19 | 9.09 | 28.27 |
| 30 | 200 | 43.59 | 14.85 | 69.71 | 8.68 | 30.21 |
| 35 | 300 | 87.18 | 12.92 | 78.00 | 7.79 | 34.38 |
| 40 | 410 | | | | | |
| 45 | 520 | | | | | |
| 50 | 610 | | | | | |

(1) First series. (2) Second series.

## Distribution of Phenol between Water and Carbon Tetra Chloride at 20°.

(Vaubel — J. pr. Ch. [2] 67, 476, '03.)

| Gms. Phenol Used. | Volumes of Solvents. | Grams Phenol in: $H_2O$ Layer. | Grams Phenol in: $CCl_4$ Layer. |
|---|---|---|---|
| 1 | 50 cc. $H_2O$ + 10 cc. $CCl_4$ | 0.8605 | 0.1285 |
| 1 | " + 20 cc. " | 0.7990 | 0.1900 |
| 1 | " + 30 cc. " | 0.7275 | 0.2615 |
| 1 | " + 50 cc. " | 0.6435 | 0.3455 |
| 1 | " + 100 cc. " | 0.4680 | 0.5210 |
| 1 | " + 150 cc. " | 0.3645 | 0.6245 |
| 1 | " + 200 cc. " | 0.3240 | 0.6650 |

## Distribution of Phenol between Water and Organic Solvents at 25°.

(Herz and Rathmann, 1913.)

Results for:

### $H_2O$ and Chloroform.

| Mols. $C_6H_5OH$ per Liter. | |
|---|---|
| $H_2O$ Layer. | $CHCl_3$ Layer. |
| 0.0737 | 0.254 |
| 0.163 | 0.761 |
| 0.211 | 1.27 |
| 0.330 | 3.36 |
| 0.436 | 5.43 |

### $H_2O$ and Carbon Tetrachloride.

| Mols. $C_6H_5OH$ per Liter. | |
|---|---|
| $H_2O$ Layer. | $CCl_4$ Layer. |
| 0.0605 | 0.0247 |
| 0.140 | 0.072? |
| 0.213 | 0.141 |
| 0.355 | 0.392 |
| 0.489 | 1.47 |
| 0.525 | 2.49 |

### $H_2O$ and Tetrachlor Ethane.

| Mols. $C_6H_5OH$ per Liter. | |
|---|---|
| $H_2O$ Layer. | $C_2H_2Cl_4$ Layer. |
| 0.023 | 0.061 |
| 0.0345 | 0.094 |
| 0.081 | 0.265 |
| 0.114 | 0.406 |
| 0.151 | 0.617 |
| 0.155 | 0.651 |

### $H_2O$ and Pentachlor Ethane.

| Mols. $C_6H_5OH$ per Liter. | |
|---|---|
| $H_2O$ Layer. | $C_2HCl_5$ Layer. |
| 0.0420 | 0.0495 |
| 0.0866 | 0.110 |
| 0.150 | 0.226 |
| 0.222 | 0.432 |
| 0.280 | 0.708 |
| 0.333 | 1.170 |

### $H_2O$ and Trichlor Ethylene.

| Mols. $C_6H_5OH$ per Liter. | |
|---|---|
| $H_2O$ Layer. | $CHCl:CCl_2$ Layer. |
| 0.044 | 0.046 |
| 0.101 | 0.107 |
| 0.180 | 0.236 |
| 0.236 | 0.388 |
| 0.277 | 0.555 |
| 0.339 | 0.986 |

### $H_2O$ and Tetrachlor Ethylene.

| Mols. $C_6H_5OH$ per Liter. | |
|---|---|
| $H_2O$ Layer. | $CCl_2:CCl_2$ Layer. |
| 0.0653 | 0.0277 |
| 0.143 | 0.0650 |
| 0.327 | 0.198 |
| 0.421 | 0.411 |
| 0.490 | 0.684 |

## Distribution of Phenol at 25° between:

(Herz and Fischer — Ber. 38, 1143, '05.)

### Water and Toluene.

| Millimols $C_6H_5OH$ per 10 cc. | | Grams $C_6H_5OH$ per 100 cc. | |
|---|---|---|---|
| $C_6H_5CH_3$ Layer. | $H_2O$ Layer. | $C_6H_5CH_3$ Layer. | $H_2O$ Layer. |
| 1.244 | 0.724 | 1.169 | 0.681 |
| 3.047 | 1.469 | 2.865 | 1.381 |
| 4.667 | 2.200 | 4.389 | 2.068 |
| 6.446 | 2.861 | 6.061 | 2.691 |
| 14.960 | 4.750 | 14.07 | 4.467 |
| 17.725 | 5.346 | 16.69 | 5.027 |
| 47.003 | 7.706 | 44.20 | 7.246 |
| 53.783 | 8.087 | 50.58 | 7 604 |
| 90.287 | 9.651 | 84.89 | 9.074 |

### Water and *m* Xylene.

| Millimols $C_6H_5OH$ per 10 cc. | | Grams $C_6H_5OH$ per 100 cc. | |
|---|---|---|---|
| $mC_6H_4(CH_3)_2$ Layer. | $H_2O$ Layer. | $mC_6H_4(CH_3)_2$ Layer. | $H_2O$ Layer. |
| 1.610 | 1.071 | 1.514 | 1.007 |
| 4.787 | 2.726 | 4.501 | 2.563 |
| 12.210 | 5.168 | 11.22 | 4.860 |
| 22.718 | 6.994 | 21.36 | 6.577 |
| 34.827 | 8.124 | 32.75 | 7.640 |
| 51.352 | 9.123 | 48.28 | 8.578 |
| 77.703 | 10.050 | 73.07 | 9.450 |

## Distribution of Phenol between: Amyl Alcohol and Water at 25°.

(Herz and Fischer — Ber. 37, 4747, '04.)

| Millimols Phenol per 10 cc. | | Gms. Phenol per 100 cc. | |
|---|---|---|---|
| Alcoholic Layer. | Aqueous Layer. | Alcoholic Layer. | Aqueous Layer. |
| 0.75 | 0.047 | 0.705 | 0.0441 |
| 0.9 | 0.05 | 0.846 | 0.047 |
| 1.1 | 0.07 | 1.035 | 0.066 |
| 2.6 | 0.16 | 2.445 | 0.150 |
| 54.1 | 3.83 | 50.88 | 3.601 |
| 56.3 | 3.9 | 52.93 | 3.667 |

## Benzene and Water at 20°.

(Vaubel — J. pr. Ch. [2] 67, 476, '03.)

| Volumes of Solvents used per 1 Gm. Phenol | Gms. Phenol in: $H_2O$ Layer. | Gms. Phenol in: $C_6H_6$ Layer |
|---|---|---|
| 50 cc. $H_2O$ + 50 cc. $C_6H_6$ | 0.286 | 0.714 |
| " + 100 cc. " | 0.1188 | 0.8212 |
| " + 150 cc. " | 0.0893 | 0.9107 |
| " + 200 cc. " | 0.0893 | 0.9107 |

## Distribution of Phenol between Water and Benzene at 20°.

(Philip and Bramley, 1915.)

| Gms. Phenol per Liter. | | Ratio $\frac{b}{a}$. | Gms. Phenol per Liter. | | Ratio $\frac{b}{a}$. |
|---|---|---|---|---|---|
| Aq. Layer, *a*. | $C_6H_6$ Layer, *b*. | | Aq. Layer, *a*. | $C_6H_6$ Layer, *b*. | |
| 0.945 | 2.073 | 2.194 | 0.356 | 0.7736 | 2.173 |
| 0.888 | 1.944 | 2.189 | 0.238 | 0.5177 | 2.175 |
| 0.711 | 1.553 | 2.184 | 0.119 | 0.2594 | 2.180 |
| 0.594 | 1.293 | 2.176 | 0.0601 | 0.1314 | 2.189 |
| 0.475 | 1 036 | 2.181 | | | |

Results are also given for the effect of NaCl, KCl and of LiCl upon the above distribution.

## Distribution of Phenol Between Water and Benzene at 25°.

(Philip and Clark, 1925.)

| Gms. Mols. $C_6H_5OH$ per liter | | $\frac{1}{2}$ | Gm. Mols. $C_6H_5OH$ per liter | | $\frac{1}{2}$ |
|---|---|---|---|---|---|
| $H_2O$ layer(1) | $C_6H_6$ layer(2) | | $H_2O$ layer(1) | $C_6H_6$ layer(2) | |
| 0.00202 | 0.00466 | 0.433 | 0.01829 | 0.04370 | 0.419 |
| 0.00565 | 0.01324 | 0.427 | 0.03105 | 0.07485 | 0.415 |
| 0.00797 | 0.01859 | 0.429 | 0.05306 | 0.1329 | 0.399 |
| 0.01094 | 0.02528 | 0.433 | 0.1029 | 0.2913 | 0.353 |
| 0.01440 | 0.03428 | 0.420 | 0.2531 | 1.198 | 0.211 |

## Distribution of Phenol Between Water and Collodion.

(Northrup, 1929.)

| Gm. Mol. $C_6H_5OH$ per liter | | $\frac{2}{1}$ |
|---|---|---|
| $H_2O$ layer(1) | Collodion(2) | |
| 0.025 | 0.071 | (2.8) |
| 0.05 | 0.20 | (4.0) |
| 0.28 | 0.10 | 2.8 |
| 0.57 | 0.20 | 2.8 |

## PHENOL

### Distribution of Phenol Between Benzene and Aqueous Solutions of Silver Nitrate at 25°.

(Endo, 1927.)

| Gm. Mol. $AgNO_3$ per liter aq. layer | Gm. Mol. $C_6H_5OH$ per liter: Aq. layer | Gm. Mol. $C_6H_5OH$ per liter: $C_6H_6$ layer | Gm. Mol. $AgNO_3$ per liter aq. layer | Gm. Mol. $C_6H_5OH$ per liter: Aq. layer | Gm. Mol. $C_6H_5OH$ per liter: $C_6H_6$ layer |
|---|---|---|---|---|---|
| 0.25 | 0.0564 | 0.1079 | 1.0 | 0.0829 | 0.0813 |
| " | 0.1174 | 0.2111 | " | 0.1588 | 0.1697 |
| " | 0.1866 | 0.4189 | " | 0.3197 | 0.3862 |
| " | 0.2303 | 0.6429 | " | 0.4190 | 0.5665 |
| " | 0.3092 | 0.9561 | " | 0.5966 | 1.1136 |
| 0.50 | 0.0680 | 0.0963 | 2.0 | 0.0988 | 0.0615 |
| " | 0.1303 | 0.1982 | " | 0.2056 | 0.1229 |
| " | 0.2181 | 0.3905 | " | 0.4129 | 0.2836 |
| " | 0.3139 | 0.6716 | " | 0.6965 | 0.5688 |
| " | 0.3637 | 0.9177 | " | 0.8517 | 0.8213 |

### Distribution of Phenol Between Benzene and Aqueous 0.3 Normal Salt Solutions at 25°.

(Herz and Stanner, 1927.)

| Aq. 3.0 N Solutions of: | Gm. Mol. $C_6H_5OH$ per liter: Aq. layer(1) | $C_6H_6$ layer(2) | $\frac{2}{1}$ | Aq. 3.0 N Solutions of: | Gm. Mol. $C_6H_5OH$ per liter: Aq. layer(1) | $C_6H_6$ layer(2) | $\frac{2}{1}$ |
|---|---|---|---|---|---|---|---|
| $H_2O$ alone | 0.0400 | 0.0895 | 2.24 | KBr | 0.0230 | 0.1203 | 5.23 |
| " | 0.0588 | 0.1331 | 2.26 | " | 0.0334 | 0.1700 | 5.09 |
| " | 0.0718 | 0.1668 | 2.32 | " | 0.0448 | 0.2255 | 5.03 |
| " | 0.1183 | 0.2731 | 2.31 | " | 0.0571 | 0.3010 | 5.27 |
| LiCl | 0.0204 | 0.1250 | 6.13 | $K_2SO_4$ (1) | 0.0306 | 0.1062 | 3.47 |
| " | 0.0313 | 0.1883 | 6.02 | " | 0.0468 | 0.1620 | 3.46 |
| " | 0.0403 | 0.2500 | 6.20 | " | 0.0634 | 0.2265 | 3.57 |
| " | 0.0512 | 0.3093 | 6.04 | " | 0.0796 | 0.2870 | 3.61 |
| NaCl | 0.0177 | 0.1203 | 6.80 | $MgCl_2$ | 0.0188 | 0.1152 | 6.13 |
| " | 0.0266 | 0.1789 | 6.73 | " | 0.0296 | 0.1800 | 6.08 |
| " | 0.0350 | 0.2503 | 7.15 | " | 0.0399 | 0.2487 | 6.23 |
| " | 0.0440 | 0.3158 | 7.18 | $CaCl_2$ | 0.0188 | 0.1196 | 6.36 |
| NaBr | 0.0181 | 0.1133 | 6.26 | " | 0.0296 | 0.1829 | 6.18 |
| " | 0.0280 | 0.1769 | 6.32 | " | 0.0384 | 0.2389 | 6.22 |
| " | 0.0379 | 0.2443 | 6.45 | " | 0.0526 | 0.3324 | 6.32 |
| " | 0.0483 | 0.3049 | 6.31 | $SrCl_2$ | 0.0188 | 0.1199 | 6.38 |
| $Na_2SO_4$ (1) | 0.0291 | 0.1180 | 4.05 | " | 0.0281 | 0.1796 | 6.39 |
| " | 0.0414 | 0.1689 | 4.08 | " | 0.0379 | 0.2491 | 6.57 |
| " | 0.0590 | 0.2255 | 3.82 | " | 0.0468 | 0.3147 | 6.72 |
| " | 0.0792 | 0.2958 | 3.93 | $BaCl_2$ | 0.0188 | 0.1229 | 6.54 |
| KCl | 0.0191 | 0.1084 | 5.67 | " | 0.0287 | 0.1791 | 6.24 |
| " | 0.0309 | 0.1779 | 5.76 | " | 0.0375 | 0.2520 | 6.72 |
| " | 0.0409 | 0.2364 | 5.78 | " | 0.0468 | 0.3197 | 6.83 |
| " | 0.0518 | 0.3014 | 5.82 | | | | |

(1) The concentration was 0.5 equivalent normal instead of 3.0 normal.

## Reciprocal Solubility of Camphor and Phenol, Determined by the Freezing-point Method.

(Wood and Scott, 1910.)

(The freezing-point was determined in most cases by measuring the rate of cooling of the mixtures and ascertaining the point at which the rate changed. The experiments were made with very great care.)

| t° of Freezing. | Gms. Camphor per 100 Gms. Mixture. | Solid Phase. | t° of Freezing. | Gms. Camphor per 100 Gms. Mixture. | Solid Phase. | t° of Freezing. | Gms. Camphor per 100 Gms. Mixture. | Solid Phase. |
|---|---|---|---|---|---|---|---|---|
| 174.5 | 100.0 | $C_{10}H_{16}O$ | −13.8 | 71.48 | $C_{10}H_{16}O$ | −22.6 | 52.52 | 1.1 |
| 158 | 95.98 | " | −26.4, −32 | 70.12 | " +1.1 | −23.6 | 44.90 | " |
| 140 | 92.55 | " | −15.9 | 69.32 | 1.1 | −28−30.5 | 40.35 | "+$C_6H_5OH$ |
| 112 | 88.86 | " | −20.1 | 67.76 | " | −15.7 | 38.5? | $C_6H_5OH$ |
| 80 | 82.88 | " | −19.3 | 66.64 | " | −3 | 34.50 | " |
| 50.7 | 79.73 | " | −18.7 | 62.21 | " | +5 | 30.31 | " |
| 29.5 | 76.58 | " | −18.6 m. pt. | ... | " | 16.1 | 25.40 | " |
| −0.1 | 73.37 | " | −20.1 | 61.51 | " | 25 | 20.31 | " |
| −13.5 | 72.24 | " | −20 | 55.80 | " | 36.1 | 6.87 | " |

1.1 = $C_{10}H_{16}O.C_6H_5OH$.

Data for the above system obtained by the method of determination of the temperature of disappearance of the last crystal, are given by Kremann, Wischo and Paul (1915). The results are not in good agreement with the above. These authors also give similar determinations for the systems camphor+resorcinol and camphor+$\beta$ naphthol.

Data for the systems camphor + phenol + water, camphor + *n* butyric acid + water, camphor + succinic acid nitrile + water and camphor + triethylamine + water are given by Timmermans, 1907.

## Solubility of Phenol in Benzene and in Paraffin.

(Schweissinger, 1884–85.)

| Solvent. | Gms. $C_6H_5OH$ per 100 Gms. Solvent at: | | | |
|---|---|---|---|---|
| | 16°. | 21°. | 25°. | 43°. |
| Paraffin | 1.66 | ... | ... | 5 |
| Benzene | 2.5 | 8.33 | 10 | 100 |

Data for equilibrium in systems composed of phenol, water and each of the following compounds are given by Timmermans (1907): NaCl, KCl, KBr, $KNO_3$, $K_2SO_4$, $MgSO_4$, tartaric acid, salicylic acid, succinic acid and sodium oleate.

The critical solution temperature of mixtures of phenol and iso amyl butyrate is about 7°. (Lecat, 1927.)

100 gms. sat. solution of phenol in liquid sulfur dioxide contain 28 gms. $C_6H_5OH$ at t°(?). (De Carli, 1927.)

Freezing-points of mixtures of Phenol and:

Acetamide(5)(29)(55)
Acetanilide(3)
Acetone(41)(60)
Aceto phenone(33)
Acetic acid(41)
Amido phenols(38)
Aniline(8)
Antipyrine(32)
Benzamide(29)
Benzaldehyde(54a)
Benzoic acid(43)
Benzo hydrol(25)(54a)
Benzo phenone(36)
Benzoyl chloride(58)
Benzylamine(49)
Bromo toluene(47)
Camphor(13)(56)
Chloro acetic acid(40) (24)(41)
Chloro acetic acid + naphthalene(40)
Cineole(6)
Cinnamic acid(37)
Cresols(10)(11)(12)
Cyclohexanol(45)
Di ethyl di acetyl tartartrate( )
Di methyl aniline(2)(22)
Di methyl methane(47)
Di methyl oxalate(37)
Di methyl pyrone(17)
Di methyl ureas(23)
Di phenyl amine(46)
Di phenyl methane(47)
Di phenyl methyl amine(2)
Erythritol(51)
Ethyl alcohol + acetamide(29)(55)
Ethylene bromide(9)(47)
Ethylene diamine(50)
Fenchon(26)
Methyl urea(23)
Naphthalene(4)(15)(59) (25)(40)(44)
Naphthol(44)
Nitraniline(34)
Nitro benzene(9)
Nitro benzene + Quinone(35)
Nitroso di methyl aniline(4)(21)(25)
Oxybenzaldehyde(27)
Phenylene diamines(28)
Phenyl hydrazine(7)
Picric acid(21)(46)(53)
Pyridine(2)(15)
Quinone(35)
Quinone + nitrobenzene(35)
Quinoline(2)
Resorcinol(18)
Salicylic acid(1)
Salicylicaldehyde(36)
Styphnic acid(16)
Succinic acid(37)
Succinimide(26)
Sulfuric acid(19)
Thymol(14)(47)(57)
Toluidines(20)(22)(46)(48)
Tri chloro acetic acid(24)
Tri phenyl carbinol(30)
Tri phenyl methane(31)
Urea(52)(53)(34)(46)
" + Urethan(14)
Urethan(45)
Xylene(47)
Xylidines(22)(42)
Naphthylamine(22)(46)

(1) Baily, 1925; (2) Bramley, 1916; (3) Angelleti, 1928; (4) Bernoulli and Veillon, 1932; (5) Boon, 1939; (6) Belluci and Grassi, 1913; (7) Cuisa and Bernardi, 1910; (8) Deffet, 1938; (9) Dahms, 1895; (10) Dawson and Mountford, 1918; (11) Fox and Barker, 1918; (12) Fischer and Gröppel, 1917; (13) Günther and Peiser, 1927; (14) Hrynakowski and Szmyt, 1935(a); (15) Hatcher and Skirrow, 1917; (16) Jefremow, 1934; (17) Kendall, 1914a; (18) Jaeger, 1907; (19) Kendall and Carpenter, 1914; (20) Kitran, 1924; (21) Kremann, 1904; (22) Kremann, 1906; (23) Kremann, 1910; (24) Kendall, 1916; (25) Kremann and Drazil, 1924; (26) Kremann and Dietrich, 1923; (27) Kremann and Pogantsch, 1923; (28) Kremann and Petritschek, 1917; (29) Kremann and Wenzig, 1917; (30) Kremann and Wlk, 1919; (31) Kremann, Odelga and Zawodsky, 1921; (32) Kremann and Haas, 1919; (33) Kremann and Marktl(1920) (34) Kremann and Rodinis; 1906; (35) Kremann, Sutter, Sitte, Strzelba and Dobolzky, 1922; (36) Kremann and Zechner, 1918; 1925; (37) Kremann, Zechner and Drazil, 1921; (38) Kremann, Lupfer and Zawodsky, 1920; (40) Mameli and Mannessier-Mameli,1933; (41) Mameli and Cocconi, 1923; (42) Morgan and Pettet, 1935; (43) Moermann, 1933; (44) Migliacci and Garguilo, 1927; (45) Mascarelli and Pestalozza, 1908, 1909; (46) Philip, 1903; (47) Paterno and Ampola,; (48) Puschin, 1926b; (49) Puschin and Rikovski, 1937; (50) Puschin and Sladovick, 1928(a); (51) Puschin and Dezelic, 1932; (42) Puschin and König, 1928; (53) Rheinboldt, Henning and Kirscheisen, 1925; (54) Schmidlin and Lang, 1910; (54a) Schmidlin and Lang, 1912; (55) Speyers, 1902; (56) Wood and Scott, 1910; (57) Wilcox and Bailey, 1929; (58) Tsakalotos and Guye, 1910; (59) Yamamoto, 1908; (60) Waddell, 1889.

NITROSO ANILINE p $NOC_6H_4NH_2$.

Freezing-point data for mixture of p nitroso aniline and p nitraniline are given by Jaeger and van Kregten, 1912.

PYROCATECHOL o $C_6H_4(OH)_2$.

SOLUBILITY OF PYROCATECHOL IN WATER AND IN OTHER SOLVENTS.
(Walker, Collett and Lazell, 1931.)

The determinations were made by the synthetic method. In order to prevent oxidation the air in the sealed bulbs was replaced by hydrogen. The determinations were plotted and the following values obtained from the curves.

| $t^0$ | Gm. Mols. o $C_6H_4(OH)_2$ per 100 gm. mols. sat. solution in: | | | | | | |
|---|---|---|---|---|---|---|---|
| | Water | Ethyl Alcohol | Ethyl Ether | Acetone | Carbon Tetrachloride | Chloroform | Benzene |
| 20 | 6.88 | 36.40 | — | 50.08 | 0.10 | 2.10 | 0.60 |
| 30 | 14.10 | 39.80 | — | 52.20 | 0.35 | 2.70 | 1.15 |
| 40 | 21.95 | 43.95 | 46.95 | 54.48 | 0.60 | 3.30 | 1.80 |
| 50 | 30.78 | 48.92 | 51.10 | 57.58 | 0.95 | 4.32 | 3.02 |
| 60 | 40.25 | 54.37 | 55.86 | 61.55 | 1.18 | 7.38 | 5.35 |
| 70 | 51.65 | 60.38 | 61.55 | 66.42 | 1.75 | 14.70 | 10.60 |
| 80 | 64.69 | 68.20 | 68.50 | 77.65 | 3.15 | 39.20 | 29.55 |
| 90 | 78.70 | 80.09 | 77.85 | 80.35 | 15.80 | 67.18 | 64.30 |
| 100 | 93.20 | 93.55 | 92.40 | 93.00 | 89.42 | 89.45 | 90.32 |
| 104.5 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |

**PYROCATECHOL** o $C_6H_4(OH)_2$.

100 gms. $H_2O$ dissolve 45.1 gms. $C_6H_4(OH)_2$ at 20°. (Vaubel, 1899.)
100 gms. pyridine dissolve an unlimited amount of $C_6H_4(OH)_2$ at 20°. (Dehn, 1917.)
100 gms. aq. 50% pyridine dissolve 101 + gms. of $C_6H_4(OH)_2$ at 20–25°. "

SOLUBILITY OF PYROCATECHOL IN AQUEOUS SOLUTIONS OF HYDROCHLORIC ACID AT 25°.

(Knox and Richards, 1919.)

| Normality | |
|---|---|
| HCl. | $C_6H_4(OH)_2$. |
| 0.0 | 4.19 |
| 1.68 | 2.13 |
| 3.53 | 1.18 |
| 5.39 | 0.81 |
| 7.30 | 0.62 |
| 9.11 | 0.55 |
| 10.83 | 0.55 |

**PYROCATECHOL** Arsenic Acid $[O:As(O.C_6H_4O)_3]H_3 + 4H_2O$.

100 gms. sat. solution in water contain 42.4 gms. of the compound at ord. temps.
" " " " alcohol " 82.7 " " " " "

(Weinland and Hemzler, 1920.)

Freezing-points of mixtures of Pyrocatechol and:

Acetamide(22)
Acetone(36)
Acetophenone(17)
Amino phenols(6)
Aniline(27)
Antipyrine(18)
" + Hydroquinone(4)(5)
" + Resorcinol(4)(11)
Azo benzene(28)
Benzamide(22)
Benzo hydrol(23)(40)
Benzo phenone(7)(39)
Camphor(12)(6)
Carbazole(15)
Cineole(2)
Cinnamic acid(26)
Cinnamic aldehyde(30)
Di methyl oxalate(26)
Di phenyl amine(14)
Di phenyl methane(20)
Ethylene diamine(33)
Fenchon(23)
Hydroquinone(37)
" + antipyrine(4)(5)
Naphthalene(19)(35)
Naphthylamine(34)
Nitro naphthalene(37)
Oxy benzaldehyde(29)
Phenanthrene(1)
Phenyl tetra methyl tetra hydro pyran (3)
Phenylene diamine(24)(31)
Picric acid(34)
Quinone(25)
Resorcinol(37)(10)
" + antipyrine(4) + hydroquinone(4)
Styphnic acid(9)
Succinic acid(26)
Succinimide(23)
Tetra methyl phthalan(3)
Toluidine(34)
Tri chloro acetic acid(8)
Tri phenyl carbinole(21)
Tri phenyl methane(13)
Urea(32)(38)
Urethan(32)

(1) Bernoulli and Sarasin, 1930; (2) Bellucci and Grassi, 1913; (3) Bennett and Wain, 1936; (4) Hrynakowski, 1934; (5) Hrynakowski and Adamis, 1937; (6) Jefremow, 1912, 1913; (7) Freundlich and Posnjak, 1912; (8) Kitran, 1924; (9) Jefremow, 1934; (10) Jaeger, 1907; (11) Jaeger, 1905; (12) Kremann and Odelga, 1921; (13) Kremann, Odelga and Zawodsky, 1921; (14) Kremann and Schadinger, 1919; (15) Kremann and Slovak, 1920; (16) Kremann, Lupfer and Zawodsky, 1920; (17) Kremann and Marktl, 1920; (18) Kremann and Haas, 1909; (19) Kremann and Janetzky, 1912; (20) Kremann and Fritsch, 1920; (21) Kremann and Wlk, 1919; (22) Kremann and Auer, 1918; (23) Kremann and Dietrich, 1923; (24) Kremann and Strohschneider, 1918; (25) Kremann, Sutter, Sitte, Strzelba and Dobotzky, 1922; (26) Kremann, Zechner and Drazil, 1924; (27) Kremann, 1906; (28) Kremann Zechner and Weber, 1924; (29) Kremann and Pogantsch, 1923; (30) Kremann, Hönigsberg and Mauermann, 1923; (31) Naegli and Kaltman, 1933; (32) Puschin and Rikovsky, 1932; (33) Puschin and Sladovick, 1928a; (34) Philip and Smith, 1905; (35) Rheinboldt, Henning and Kirscheisen, 1925; (36) Schmidlin and Lang, 1910; (37) Senden, 1923; (38) Van der Hammen, 1931; (39) Kremann and Zechner, 1918; (40) Kremann and Drazil, 1924.

## RESORCINOL $C_6H_4(OH)_2$ 1, 3.

### Solubility of Resorcinol in Water.

(Loskit, 1928.)

The determinations were made by the synthetic and also by the freezing-point method. The author's results were plotted and the following values taken from the average curve.

| $t^o$ | Gms. $C_6H_4(OH)_2$ per 100 gms. sat. sol. | Solid Phase |
|---|---|---|
| -0.1 | 6.4 | Ice |
| -0.2 | 16.0 | " |
| -0.3 | 22.0 | " |
| -0.4 | 27.5 | " |
| -0.5(Eutec.) | 34.0 | " + $C_6H_4(OH)_2$ |
| -0.6(Unstable) | 40.0 | " |
| 0.0 | 40 | $C_6H_4(OH)_2$ |
| 10.0 | 50 | " |
| 20 | 58.5 (58.3) | " |
| 25 | 62.5 | " |
| 30 | 66.0 (66.2) | " |
| 40 | 72.7 (72.7) | " |
| 50 | 78.3 | " |
| 60 | 83.5 (83.3) | " |
| 70 | 87.7 | " |
| 80 | 91.5 (91.2) | " |
| 90 | 94.5 | " |

The results in parentheses have been recalculated from those of Walker, Collett and Lazzel, 1931, which are given in terms of molecular percent.

The previous results of Speyers, 1902 and of Mortimer, 1923, are lower than the above values.

SOLUBILITY OF RESORCINOL IN WATER AND IN ETHYL ALCOHOL. (Speyers, 1902.)

Results for Water.

| t°. | *d* of sat. sol. | Gms. $C_6H_4(OH)_2$ (*m*) per 100 gms. $H_2O$. |
|---|---|---|
| 0..... | 1.101 | 66.2 |
| 10..... | 1.118 | 93.5 |
| 20 ..... | 1.134 | 123 |
| 25..... | 1.142 | 143 |
| 30..... | 1.148 | 166 |
| 40 ... . | 1.157 | 225 |
| 50..... | 1.165 | 300 |
| 60... .. | 1.172 | 390 |
| 70.... . | 1.176 | 495 |
| 80..... | 1.179 | 634 |

Results for Alcohol.

| t°. | *d* of sat. sol. | Gms. $C_6H_4(OH)_2$ (*m*) per 100 gms. $H_2O$. |
|---|---|---|
| 0..... | 1.033 | 125 |
| 10..... | 1.036 | 141 |
| 20..... | 1.041 | 155 |
| 25 ..... | 1.045 | 162 |
| 30..... | 1.048 | 170 |
| 40. .... | 1.056 | 186 |
| 50..... | 1.065 | 206 |
| 60..... | 1.075 | 235 |
| 70..... | 1.087 | 300 |
| 73..... | 1.092 | 330 |

SOLUBILITY OF RESORCINOL IN AQUEOUS SOLUTIONS OF HYDROCHLORIC ACID AT 25°. (Knox and Richards, 1919.)

Saturation was obtained by constant shaking in a thermostat for several days.

| Equiv. Normality. | | Equiv. Normality. | | Equiv. Normality. | |
|---|---|---|---|---|---|
| HCl. | $C_6H_4(OH)_2$. | HCl. | $C_6H_4(OH)_2$. | HCl. | $C_6H_4(OH)_2$. |
| 0.0 | 6.515 | 4.402 | 2.307 | 9.610 | 1.118 |
| 0.656 | 5.705 | 6.076 | 1.616 | 11.31 | 1.389 |
| 1.671 | 4.570 | 7 567 | 1.287 | | |
| 3.410 | 3.020 | 9.157 | 1.125 | | |

According to Vaubel (1895), 100 gms. $H_2O$ dissolve 175.5 gms. $C_6H_4(OH)_2$, or 100 gms. sat. solution contain 63.7 gms. at 20°. Sp. Gr. of sol. = 1.1335.

SOLUBILITY OF RESORCINOL IN ALCOHOLS AND IN ACIDS.
(Timofeiew, 1894.)

| Solvent. | t°. | Gms. $C_6H_4(OH)_2$ *m* per 100 Gms. Sat. Sol. | Solvent. | t°. | Gms. $C_6H_4(OH)_2$ *m* per 100 Gms. Sat. Sol. |
|---|---|---|---|---|---|
| Methyl Alcohol | 11.6 | 69 | Formic Acid | 15 | 29.2 |
| Ethyl " | 10.4 | 59.2 | Acetic " | 15 | 32.5 |
| " " | 11.6 | 61.5 | Propionic " | 15 | 22.8 |
| Propyl " | 10.4 | 51.5 | Butyric " | 15 | 14.7 |
| " " | 11.6 | 51.6 | Isobutyric " | 15 | 9.6 |
| | | | Valeric " | 15 | 6.5 |

100 gms. abs. alcohol dissolve about 236 gms. $C_6H_4(OH)_2$ (*m*) at 20-25°.
100 gms. equi. mol. mixture of alcohol and quinoline dissolve about 99.8 gms. $C_6H_4(OH)_2$ (*m*) at 20-25°.
(Pucher and Dehn, 1921.)

## RESORCINOL

### Solubility of Resorcinol in Several Solvents.

(Walker, Collett and Lazzell, 1931.)

The determinations were made by the synthetic method. In order to prevent oxidation the air in the sealed tubes was replaced by hydrogen. The determinations were plotted and the following values obtained from the curves.

| t° | Gm. Mols. *m* $C_6H_4(OH)_2$ per 100 gm. mols. sat. solution in: | | | | | |
|---|---|---|---|---|---|---|
| | Water | Ethyl Alcohol | Acetone | Carbon Tetrachloride | Chloroform | Benzene |
| 20 | 18.65 | 39.34 | 51.55 | — | — | (0.15) |
| 30 | 24.25 | 41.91 | 53.94 | 0.07 | 0.63 | 0.40 |
| 40 | 30.44 | 44.79 | 56.20 | 0.17 | 0.84 | 0.60 |
| 50 | 37.49 | 48.40 | 58.63 | 0.27 | 1.06 | 0.75 |
| 60 | 45.00 | 53.10 | 61.38 | 0.38 | 1.27 | 1.00 |
| 70 | 53.45 | 58.34 | 65.25 | 0.47 | 1.48 | 1.76 |
| 80 | 63.01 | 64.69 | 71.21 | 0.58 | 1.70 | 3.17 |
| 90 | 73.83 | 74.65 | 79.60 | 0.69 | 5.64 | 6.40 |
| 100 | 86.09 | 87.38 | 89.35 | 0.80 | 78.50 | 79.80 |
| 109.4 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |

### Solubility of Resorcinol in Acetic Acid in Nitrobenzene and in Urethan.

(Mortimer, 1923.)

| t° | In Acetic Acid. | | In Nitrobenzene. | | In Urethan. | |
|---|---|---|---|---|---|---|
| | Mols. $C_6H_4(OH)_2$ per 100 mols. sat. sol. | Gms. $C_6H_4(OH)_2$ per 100 gms. $CH_3COOH$. | Mols. $C_6H_4(OH)_2$ per 100 mols. sat. sol. | Gms. $C_6H_4(OH)_2$ per 100 gms. $C_6H_5NO_2$. | Mols. $C_6H_4(OH)_2$ per 100 mols. sat. sol. | Gms. $C_6H_4(OH)_2$ per 100 gms. $NH_2CO_2C_2H_5$. |
| 20..... | 17.6 | 39.13 | 6.6 | 6.33 | — | — |
| 40..... | 27.2 | 69.45 | 16.0 | 17.02 | 46.8 | 108 6 |
| 60..... | 39.4 | 119.1 | 32.2 | 42.45 | 56.3 | 159 0 |
| 80..... | 56.3 | 236.0 | 55.3 | 110.6 | 68.2 | 264.7 |
| 100..... | 81.0 | 780.9 | 83.3 | 445.8 | 85.5 | 727.8 |

### Solubility of Resorcinol in Benzene.

(Rothmund, 1898.)

| t° | Gms. $C_6H_4(OH)_2$ per 100 Gms. Sat. Sol. | t°. | Gms. $C_6H_4(OH)_2$ per 100 Gms. Sat. Sol. |
|---|---|---|---|
| 73 | 3.18 | 95.5 | 61.7 |
| 77 | 4.75 | 96.5 | 77.64 |
| 82 | 6.94 | 83.46 | 98.5 |
| 95.5 | 37.44 | 90.23 | 100 |

Between the concentrations 37.44 and 61.7 at 95.5° two liquid layers are formed. The reciprocal solubilities of these two layers, determined by the synthetic method (see Note, p.292), are as follows:

| t°. | Gms. $C_6H_4(OH)_2$ per 100 Gms. | | t°. | Gms. $C_6H_4(OH)_2$ per 100 Gms. | |
|---|---|---|---|---|---|
| | $C_6H_6$ Layer. | $C_6H_4(OH)_2$ Layer. | | $C_6H_6$ Layer. | $C_6H_4(OH)_2$ Layer. |
| 60 | 4.8 | 79.4 | 90 | 13 | 71.3 |
| 70 | 6.6 | 77.5 | 100 | 19.5 | 65.7 |
| 80 | 9.2 | 75 | 105 | 24.6 | 60.7 |
| | | | 109.3 | crit. temp. | 42.4 |

Resorcinol mixes with pyridine in all proportions. (Dehn, 1917.)
100 gms. aqueous 50% pyridine dissolve 901 gms. $C_6H_4(OH)_2$ *m* at 20°–25°. "
100 cc. olive oil dissolve 4.55 gms. $C_6H_4(OH)_2$ *m* at 15°–20°. (Squire and Caines, 1905.)

The critical solution temperature of mixtures of Resorcinol and α Bromo naphthalene is 135.2° and there is 45 percent of resorcinol present. (Lecat, 1929, 1930.)

Freezing-point data are given for mixtures of Resorcinol and:

Anthracene(46)
Acetamide(18)
Acetanilide(2)
" + hydroquinone(48)
" + phenacetin(9)
Acetone(43)
Aceto phenone(24)
Amino phenols(25)
Aniline(28)
Antipyrine(22)(11)(42)
" + pyrocatechol(9)
Azobenzene(36)
Benzamide(18)
Benzo hydrol(19)
Benzoic acid(11)(42)(48)
Benzoin(8)
Benzo phenone(33)(37)(38)(49)
Camphor(7)(16)
Carbazole(29)
Cineole(4)
Cinnamic acid(34)
Cinnamic aldehyde(33)
Cinnamylidene aceto phenone(37)
Di anisal acetone(38)
Di methyl oxalate(34)
Di phenyl amine(20)(30)(11)(46)
Di phenyl amine + Urea(13)
Di phenyl methane(20)
Erythritol(40)
Ethyl oxalate(34)
Fenchon(21)
Hexane + nitrobenzene(45)
Hydroquinone(11)(14)(44)
" + pyrocatechol(9)
Hexane + nitrobenzene(45)
Naphthalene(23)(46)
Naphthol(46)
Naphthylamine(39)(46)(50)
Nitrobenzene + hexane(45)
" + quinone(31)
Nitro naphthalene(44)
Oxy benzaldehyde(27)
Phenacetine + acetanilide(9)
Phenacetine + sulfonal(9)
Phenanthrene(5)
Phenylene diamine(32)
Phenyl tetra methyl-tetra hydro pyran(3)
Phenol(14)
Pyrocatechol(44)
Quinone(31)
" + nitrobenzene(31)
Salol(11)
Succinic acid(34)
Succinimide(21)
Sulfonal(10)
" + phenacetine(9)
Styphnic acid(15)
Styrylketone(38)
Tetra methyl p diamino benzo phenone(37)(38)
Tetra methyl phthalan(3)
Toluidine(39)(46)
Tri chloro acetic acid(17)
" phenyl amine(26)
" " carbinole(35)
" " methane(26)
Urea(11)(41)(47)(48)
" + antipyrine(9)
" + di phenyl amine(13)
Urethan(1)(12)
Xylene(6)

(1) Adamanis, 1933; (2) Angeletti, 1928; (3) Bennett and Wain, 1936; (4) Bellucci and Grassi, 1913; (5) Bernouilli and Sarasin, 1930; (6) Campetti, 1917; (7) Caille, 1909; (8) Dischendorfer, 1933; (9) Hrynakowski, 1934; (10) Hrynakowski and Adamanis, 1933(a); (11) Hrynakowski and Adamanis, 1933(b); (12) Hrynakowski and Adamanis, 1933; (14) Jaeger, 1907; (15) Jefremow, 1934; (16) Jefremow, 1912, 1913; (17) Kitran, 1924; (18) Kremann and Auer, 1918; (19) Kremann and Drazil, 1924; (20) Kremann and Fritsch, 1920; (21) Kremann and Dietrich, 1923; (22) Kremann and Haas, 1919; (23) Kremann and Janetzky, 1912; (24) Kremann and Marktl, 1920; (25) Kremann, Lupfer and Zawodsky, 1920; (26) Kremann, Odelga and Zawodsky, 1921; (27) Kremann and Pogantsch, 1923; (28) Kremann and Rodinis, 1906; Kremann and Slovak, 1920; (30) Kremann and Schadinger, 1919; (31) Kremann, Sutter, Sitte, Strzelba and Dobolsky, 1922; (32) Kremann and Strohschneider, 1918; (33) Kremann and Zechner, 1925; (34) Kremann, Zechner and Drazil, 1924; (35) Kremann and Wlk, 1919; (36) Kremann, Zechner and Weber, 1924; (37) Pfeiffer, 1924; (38) Pfeiffer, Goebel and Angern, 1925; (39) Philip and Smith, 1905; (40) Puschin and Dezelic, 1932; (41) Puschin and König, 1928; (42) Puschin and Wilowitsch, 1925; (43) Schmidlin and Lang, 1910; (44) Senden, 1923; (45) Timmermans, 1907; (46) Vignon, 1891; (47) Van der Hammen, 1931; (48) Hrynakowski and Szmyt, 1935(b); (49) Freundlich and Posnjak, 1912. (50) Kremann and Csanyi, 1916.

### Distribution of Resorcinol Between Water and Organic Solvents at Ordinary Temperature.

(Vaubel — J. pr. Ch. [2] 67, 478, '03.)

| Gms. $C_6H_4(OH)_2$ Used. | Solvents. | Gms. $C_6H_4(OH)$ in: $H_2O$ Layer. | Gms. $C_6H_4(OH)$ in: Organic Solvent Layer. |
|---|---|---|---|
| 1.191 | 60 cc. $H_2O$ + 30 cc. Ether | 0.2014 | 0.9896 |
| 1.191 | 60 cc. $H_2O$ + 60 cc. Ether | 0.2475 | 0.9525 |
| 0.800 | 40 cc. $H_2O$ + 40 cc. Benzene | 0.5873 | 0.2127 |
| 0.800 | 40 cc. $H_2O$ + 80 cc. Benzene | 0.5773 | 0.2227 |
| 0.500 | 50 cc. $H_2O$ + 50 cc. $CCl_4$ | 0.4885 | 0.0115 |
| 0.500 | 50 cc. $H_2O$ + 100 cc. $CCl_4$ | 0.4880 | 0.0120 |
| 0.500 | 50 cc. $H_2O$ + 150 cc. $CCl_4$ | 0.4880 | 0.0120 |

The coefficient of distribution of resorcinol at 25° between olive oil and water (conc. in oil ÷ conc. in $H_2O$) is given as 0.04 by Boeseken and Waterman (1911, 1912).

## HYDROQUINONE p $C_6H_4(OH)_2$.

### Solubility of Hydroquinone in Water and in Other Solvents.

(Walker, Collett and Lazzell, 1931.)

The determinations were made by the synthetic method. In order to prevent oxidation the air in the sealed bulbs was replaced by hydrogen. The determinations were plotted and the following values obtained from the curves.

| t° | Gm. Mols. p $C_6H_4(OH)_2$ per 100 gms. mols. sat. solution in: Water | Ethyl Alcohol | Ethyl Ether | Acetone | Carbon Tetrachloride | Benzene |
|---|---|---|---|---|---|---|
| 20 | 1.16 | 17.25 | — | 11.30 | — | 0.02 |
| 30 | 1.35 | 19.40 | — | 15.00 | 0.01 | 0.04 |
| 40 | 2.10 | 21.58 | — | 18.95 | 0.07 | 0.20 |
| 50 | 3.35 | 23.89 | — | 23.45 | 0.14 | 0.50 |
| 60 | 5.45 | 26.08 | 8.39 | 30.90 | 0.20 | 0.62 |
| 70 | 8.42 | 28.57 | 12.70 | 35.22 | 0.27 | 0.80 |
| 80 | 12.61 | 31.16 | 17.07 | 37.60 | 0.33 | 0.90 |
| 90 | 18.29 | 34.25 | 21.66 | 40.58 | 0.40 | 1.00 |
| 100 | 24.50 | 37.70 | 26.30 | 44.30 | 0.47 | 1.18 |
| 110 | 31.08 | 41.83 | 31.28 | 48.35 | 0.54 | 1.41 |
| 120 | 38.50 | 47.01 | 36.85 | 52.75 | 0.60 | 2.00 |
| 130 | 47.30 | 53.60 | 43.51 | 58.18 | 0.68 | 3.08 |
| 140 | 57.01 | 61.75 | 52.60 | 64.90 | 0.95 | 4.96 |
| 150 | 68.28 | 71.56 | 63.63 | 72.71 | 1.60 | 8.10 |
| 160 | 80.74 | 82.79 | 76.90 | 82.30 | 2.20 | 72.30 |
| 172 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |

100 gms. $H_2O$ dissolve 8.02 gms. p $C_6H_4(OH)_2$ at 25°.
100 gm. mols. $H_2O$ dissolve 1.31 gm. mols. p $C_6H_4(OH)_2$ at 25°.
100 gms. $D_2O$ (heavy water) dissolve 6.11 gms. p $C_6H_4(OD)_2$ at 25°.
100 gm. mols. $D_2O$ dissolve 1.09 gm. mols. p $C_6H_4(OD)_2$ at 25°.
(Korman and LaMer, 1936.)

## Solubility of Hydroquinol in Water and in Aqueous Solutions of Hydrochloric Acid at 25°.

(Granger and Nelson, 1921; Knox and Richards, 1919.)

| Normality of aq. HCl. | Gm. mol. $C_6H_4(OH)_2$ per liter sat. sol. | | Normality of aq. HCl. | Gm. mol. $C_6H_4(OH)_2$ per liter sat. sol. | |
|---|---|---|---|---|---|
| 0.0 (= $H_2O$) | 0.666 | (K. and R.) | 3.793 | 0.282 | (K. and R.) |
| 0.0 » | 0.645 | (G and N.) | 5.728 | 0.215 | » |
| 0.01 | 0.645 | » | 7.597 | 0.188 | » |
| 0.10 | 0.633 | » | 9.237 | 0.178 | » |
| 1.0 | 0.494 | » | 10.97 | 0.166 | » |
| 1.892 | 0.402 | (K. and R.) | | | |

100 gms. sat. solution in water contain 6.7 gms. hydroquinol at 20°, Sp. Gr. of sol. = 1.012. (Vaubel, 1899.)

100 gms. 95% formic acid dissolve 6.07 gms. hydroquinol at 20.2°. (Aschan, 1913.)

## Solubility of Hydroquinol in Aqueous Solutions of Salts at 18°.

(Linderstrom-Lang, 1924.)

Due to the instability of hydroquinol at low hydrogen ion concentrations all the determinations were made in presence of 0.01 *n* hydrochloric acid. Hence in each case the solvent is composed of 0.01 *n* HCl containing the stated gram equivalents per liter (normality *n*) of the several salts.

| Aq. solvents 0.01 *n* HCl + : | Gm. mols. $C_6H_4(OH)_2$ per liter sat. sol. | Aq. solvents 0.01 *n* HCl + : | Gm. mols. $C_6H_4(OH)_2$ per liter sat. sol. | Aq. solvents 0.01 *n* HCl + : | Gm. mols. $C_6H_4(OH)_2$ per liter sat. sol. |
|---|---|---|---|---|---|
| 0.0 | 0.5103 | 0.6 *n* KBr | 0.4394 | 0.4 *n* $SrCl_2$ | 0.4444 |
| 0.835 *n* LiCl | 0.3747 | 1.2 » | 0.3787 | 0.8 » | 0.3894 |
| 2.087 » | 0.2362 | 1.8 » | 0.3281 | 1.6 » | 0.2948 |
| 3.340 » | 0.1493 | 0.6 *n* KI | 0.4427 | 3.2 » | 0.1636 |
| 4.175 » | 0.1117 | 1.2 » | 0.3923 | 0.477 *n* $AlCl_3$ | 0.4273 |
| 6.262 » | 0.0577 | 1.8 » | 0.3457 | 1.192 » | 0.3291 |
| 0.49 *n* NaCl | 0.4270 | 2.4 » | 0.3045 | 2.385 » | 0.2099 |
| 0.99 » | 0.3579 | 2.82 » | 0.2791 | 4.770 » | 0.0815 |
| 1.99 » | 0.2496 | 0.495 *n* $MgCl_2$ | 0.4299 | 0.497 *n* $LaCl_3$ | 0.4360 |
| 2.99 » | 0.1752 | 0.989 » | 0.3635 | 1.242 » | 0.3478 |
| 3.99 » | 0.1199 | 1.979 » | 0.2589 | 2.485 » | 0.2349 |
| 0.70 *n* KCl | 0.4258 | 3.958 » | 0.1308 | 4.970 » | 0.1053 |
| 1.4 » | 0.3530 | 0.598 *n* $CaCl_2$ | 0.4180 | 0.978 *n* $MgSO_4$ | 0.3708 |
| 2.1 » | 0.2940 | 1.195 » | 0.3408 | 1.956 » | 0.2632 |
| 2.8 » | 0.2546 | 2.390 » | 0.2263 | 2.934 » | 0.1809 |
| 1.2 *n* RbCl | 0.4075 | 4.780 » | 0.0978 | 1.5 *n* $H_2SO_4$ | 0.3760 |
| 1.8 » | 0.3665 | 0.4 *n* $BaCl_2$ | 0.4449 | 1.5 *n* HCl | 0.3520 |
| 2.4 » | 0.3413 | 1.2 » | 0.3417 | 1.5 *n* $Na_2SO_4$ | 0.2976 |
| 0.578 *n* CsCl | 0.4983 | 1.5 » | 0.3068 | 0.2 *n* Mannitol | 0.5030 |
| 0.867 » | 0.4961 | 1.6 » | 0.2983 | 0.4 » | 0.4925 |
| 1.733 » | 0.4913 | 2.0 » | 0.2606 | 0.6 » | 0.4828 |
| | | | | 0.8 » | 0.4721 |

## Solubility of Hydroquinol in Aqueous Solutions of Salts at 23°.75.

(Linderstrom-Lang, 1924.)

| Aq. solvents 0.01 *n* HCl + : | Gm. mols. $C_6H_4(OH)_2$ per liter sat. sol. | Aq. solvents 0.01 *n* HCl + : | Gm. mols. $C_6H_4(OH)_2$ per liter sat. sol. | Aq. solvents 0.01 *n* HCl + : | Gm. mols. $C_6H_4(OH)_2$ per liter sat. sol. |
|---|---|---|---|---|---|
| 0.0 | 0.6144 (1) | 1.5 *n* KI | 0.458 (1) | 1.438 » | 0.5890 |
| 0.0 | 0.6180 | 1.5 *n* $KNO_3$ | 0.4912 (1) | 0.598 *n* $CaCl_2$ | 0.5072 |
| 0.669 *n* LiCl | 0.4844 | 0.5 *n* $K_2SO_4$ | 0.4788 (1) | 1.195 » | 0.4177 |
| 1.338 » | 0.3787 | 0.4 *n* NaCl | 0.5353 | 2.390 » | 0.2786 |
| 2.676 » | 0.2324 | 0.8 » | 0.4631 | 3.585 » | 0.1850 |
| 4.113 » | 0.1427 | 1.6 » | 0.3487 | 0.4 *n* $BaCl_2$ | 0.5385 |
| 0.7 *n* KCl | 0.5132 | 3.2 » | 0.1950 | 0.8 » | 0.4724 |
| 1.4 » | 0.4278 | 0.479 *n* CsCl | 0.6045 | 1.2 » | 0.4139 |
| 2.8 » | 0.3010 | 0.959 » | 0.5964 | 1.6 » | 0.3606 |
| 1.5 *n* KBr | 0.4351 (1) | | | | |

(1) Kruyt and Robinson, 1926.

## Solubility of Hydroquinone in Aqueous Solutions of Salts at 17.9°.

(Linderstrom-Lang, 1929.)

| Aqueous Solvent | Gm. Mols. p $C_6H_4(OH)_2$ per liter sat. sol. | Aqueous Solvent | Gm. Mols. p $C_6H_4(OH)_2$ per liter sat. sol. |
|---|---|---|---|
| $H_2O$ alone | 0.5077 | 0.747 n $C_4H_5NH_2.HCl$ | 0.5225 |
| 0.8 $NH_4Cl$ | 0.4322 | 1.493 n " | 0.5504 |
| 1.6 n " | 0.3741 | 2.986 n " | 0.6624 |
| 3.2 n " | 0.2895 | 0.69 n $C_4H_9NH_2.HCl$ | 0.6311 |
| 0.666 n $CH_3NH_2.HCl$ | 0.4977 | 1.39 n " | 0.8084 |
| 1.332 n " | 0.4913 | 0.277 n $(CH_3)_3(C_2H_5)N.HCl$ | 0.6775 |
| 2.663 n " | 0.4825 | 0.705 n $(C_2H_5)_4N.HCl$ | 1.4013 |
| | | 1.410 n " " | 2.3896 |

## Equilibrium in the System Hydroquinol, Phenol and Water

(Leone and Angelescu, 1922.)

Synthetic mixtures of weighed amounts of the three components were made and the temperatures of clearing and of clouding of each were determined. Different amounts of phenol were first added to known concentrations of aqueous hydroquinol and then different amounts of hydroquinol were added to known concentrations of aqueous phenol solutions.

Aq. 1.02 % $C_6H_4(OH)_2$.

| t°. | Gms. $C_6H_5OH$ per 100 gms. mixture. |
|---|---|
| 22.0..... | 8.68 |
| 53.6..... | 15.14 |
| 60.6..... | 21.90 |
| 62.4..... | 27.52 |
| 63.0..... | 33.42 |
| 63.4..... | 40.00 |
| 63.0..... | 45.10 |
| 61.8..... | 49.17 |
| 58.4..... | 54.69 |
| 54.2..... | 58.32 |
| 48.4..... | 62.93 |
| 37.2..... | 66.37 |
| 32.0..... | 66.89 |

Aq. 4.77 % $C_6H_4(OH)_2$.

| t°. | Gms. $C_6H_5OH$ per 100 gms. mixture |
|---|---|
| 34.0..... | 16.05 |
| 42.6..... | 21.54 |
| 47.4..... | 27.84 |
| 50.8..... | 36.18 |
| 52.2..... | 40.88 |
| 53.0..... | 44.88 |
| 52.6..... | 47.78 |
| 49.2..... | 55.03 |
| 45.6..... | 58.08 |
| 40.8..... | 61.44 |
| 32.6..... | 65.13 |
| 26.6..... | 57.13 |

Aq. 9.16 % $C_6H_4(OH)_2$.

| t°. | Gms. $C_6H_5OH$ per 100 gms. mixture |
|---|---|
| 24.2..... | 25.52 |
| 34.4..... | 34.82 |
| 40.4..... | 45.92 |
| 40.0..... | 52.14 |
| 36.8..... | 57.44 |
| 28.6..... | 62.18 |

Aq. 13.41 % $C_6H_4(OH)_2$.

| t°. | Gm. $C_6H_5OH$ per 100 gm. mixture. |
|---|---|
| 16.6..... | 33.94 |
| 24.0..... | 40.99 |
| 27.0..... | 46.02 |
| 27.0..... | 52.57 |
| 15.6..... | 62.65 |

Aq. 13.2 % $C_6H_5OH$.

| t°. | Gms. $C_6H_4(OH)_2$ per 100 gms. mixture. |
|---|---|
| 53.6..... | – |
| 49.6..... | 0.62 |
| 44.0..... | 1.93 |
| 33.6..... | 2.82 |
| 30.8..... | 3.17 |
| 29.8..... | 3.39 |
| 23.8..... | 4.02 |

Aq. 36.15 % $C_6H_5OH$.

| t°. | Gms. $C_6H_4(OH)_2$ per 100 gms. mixture. |
|---|---|
| 66.4..... | – |
| 64.8..... | 0.37 |
| 62.0..... | 0.95 |
| 56.8..... | 1.98 |
| 47.6..... | 3.72 |
| 38.8..... | 5.21 |
| 30.8..... | 6.44 |
| 26.0..... | 7.33 |

Aq. 61.97 % $C_6H_5OH$.

| t°. | Gms. $C_6H_4(OH)_2$ per 100 gms. mixture. |
|---|---|
| 51.0..... | – |
| 48.4..... | 0.52 |
| 46.2..... | 1.02 |
| 40.9..... | 2.08 |
| 35.0..... | 3.21 |
| 33.0..... | 3.51 |
| 26.8..... | 4.67 |

## Equilibrium in the System Hydroquinol, Phenol and Water at 0° and at 10°.

(Leone and Angelescu, 1922.)

The isotherms for this system were determined at 0° and at 10° using the titration. method with weight pipets.

Results at 0°.

| Gms. per 100 gms. sat. sol. | | Gms. per 100 gms. sat. sol. | |
|---|---|---|---|
| $C_6H_4(OH)_2$. | $C_6H_5OH$. | $C_6H_4(OH)_2$. | $C_6H_5(OH)$. |
| 0.0 | 7.23 | 11.50 | 39.96 |
| 1.82 | 8.67 | 11.42 | 44.16 |
| 3.04 | 8.97 | 11.05 | 47.93 |
| 4.37 | 10.09 | 9.67 | 54.92 |
| 6.66 | 13.49 | 7.34 | 60.77 |
| 8.76 | 18.94 | 5.31 | 66.10 |
| 9.85 | 23.38 | 3.78 | 69.01 |
| 10.80 | 34.17 | 1.32 | 73.31 |
| 11.25 | 39.37 | 0.0 | 75.42 |

Results at 10°.

| Gms. per 100 gms. sat.sol. | | Gms. per 100 gms. sat.sol. | |
|---|---|---|---|
| $C_6H_4(OH)_2$. | $C_6H_5OH$. | $C_6H_4(OH)_2$. | $C_6H_5OH$. |
| 0.0 | 7.40 | 9.39 | 46.70 |
| 0.42 | 8.23 | 8.71 | 51.07 |
| 4.14 | 10.54 | 8.14 | 54.91 |
| 7.99 | 20.04 | 7.14 | 58.69 |
| 9.29 | 28.01 | 5.17 | 63.65 |
| 10.07 | 40.17 | 3.27 | 67.80 |
| 10.05 | 42.80 | 0.99 | 72.00 |
| 9.59 | 44.18 | 0.0 | 73.34 |

Freezing-point data are given for mixtures of Hydroquinone and:

Acetamide(29)
Acetanilide(6)
" + resorcinol(5)
Acetone + water(39
Aceto phenone(17)
Amino phenol(36)
Aniline(22)
Antipyrine(16)(34)
" + pyrocatechol(3)(4)
Azobenzene(30)
Azoxyanisol(9)
Benzamide(29)
Benzo hydrol(13)
Benzo phenone(27)
Camphor(11)(19)
Carbazole(23)
Cineole(1)
Cinnamic acid(26)
Di methyl oxalate(26)
Di phenyl amine(24)(15)
" " methane(15)
Ethyl oxalate(26)
Fenchon(14)
Methoxy cinnamic acid(9)
Naphthalene(18)
Naphthylamine(35)(32)
Nitrobenzene + quinone(25)
Nitro naphthalene(33)
Oxy benzaldehyde(21)
Phenanthrene(2)
Phenylene diamines(37)
Pyrocatechol(3)(8)(33)
Pyrocatechol + antipyrine(3)(4)
Quinone(25)
" + nitrobenzene(25)
Resorcinol(7)(8)(3)(33)
Salicylic aldehyde(27)
Styphnic acid(12)
Succinic acid(26)
Succinimide(14)
Toluidine(32)
Tri chloro acetic acid(10)
Tri phenyl amine(20)
Tri phenyl carbinole(28)
Tri phenyl methane(20)
Tri nitrobenzene(38)
Urea(31)

(1) Bellucci and Grassi, 1913; (23) Bernoulli and Sarasin, 1930; (3) Hrynakowski, 1934; (4) Hrynakowski and Adamanis, 1937; (5) Hrynakowski and Szmyt, 1935(b); (6) Hrynakowski and Adamanis, 1933a; (7) Hrynakowski and Adamanis, 1933b; (8) Jaeger, 1907; (9) deKock, 1904; (10) Kitran, 1924; (11) Jefremow, 1912, 1913; (12) Jefremow, 1934; (13) Kremann & Drazil, 1924; (14) Kremann & Dietrick, 1923; (15) Kremann and Fritsch, 1920; (16) Kremann and Haas, 1919; (17) Kremann and Marktl; 1920; (18) Kremann and Janetzky, 1912; (19) Kremann and Odelga, 1921; (20) Kremann, Odelga and Zawodsky, 1921; (21) Kremann and Pogantsch, 1923; (22) Kremann and Rodinis, 1906; (23) Kremann and Slovak, 1920; (24) Kremann and Schadinger, 1919; (25) Kremann, Sutter, Sitte, Strzelba and Dobotsky, 1922; (26) Kremann, Zechner and Drazil, 1924; (27) Kremann and Zechner, 1918, 1925; (28) Kremann and Wlk, 1919; (29) Kremann and Auer, 1918; (30) Kremann, Zechner and Weber, 1924; (31) Puschin and Konig, 1928; (32) Philip and Smith, 1905; (33) Senden, 1923; (34) Rheinboldt, Henning and Kirscheisen, 1925; (35) Kremann and Csanyi, 1916; (36) Kremann and Lupfer, 1920; (37) Kremann and Strohschneider, 1918; (38) Sudborough and Beard, 1911; (39) Waddell, 1899.

### Solubility of Hydroquinol in Sulfur Dioxide in the Critical Vicinity.
(Centnerswer and Teletow, 1903.)

Determinations made by the Synthetic Method, for which see Note, p. 292.

| t°. | Gms. Hydroquinol per 100 Gms. $SO_2$ | t°. | Gms. Hydroquinol per 100 Gms. $SO_2$ | t°. | Gms. Hydroquinol per 100 Gms. $SO_2$ |
|---|---|---|---|---|---|
| 63 | 0.89 | 117.6 | 4.46 | 136.7 | 10.31 |
| 73.5 | 1.22 | 123.3 | 5.66 | 141.4 | 13.3 |
| 89.2 | 2.18 | 134.2 | 8.31 | 145 | 14.9 |

### Distribution of Hydroquinol between Water and Ether at 15°.
(Pinnow, 1911.)

| Conc.* Hydroquinol in: | | Conc. Hydroquinol in: | |
|---|---|---|---|
| $H_2O$ Layer. | Ether Layer. | $H_2O$ Layer. | Ether Layer. |
| 0.00502 | 0.0111 | 0.0502 | 0.1275 |
| 0.01196 | 0.0249 | 0.0818 | 0.2343 |
| 0.0128 | 0.0274 | 0.1105 | 0.3543 |
| 0.0236 | 0.0552 | 0.1411 | 0.5300 |
| 0.0455 | 0.1148 | 0.1502 | 0.5604 |

* The terms in which the conc. is expressed are not stated.

## Nitr**ANILINES** $C_6H_4NH_2NO_2$. *o*, *m*, and *p*.

### Solubility in Water.
(Carnelly and Thomson — J. Chem. Soc. 53, 768, '88; Vaubel — J. pr. Chem. [2] 52, 73, '95; above 80°, Löwenherz — Z. physik. Chem. 25, 407, '98.)

| t°. | Grams Nitraniline per Liter of Solution. | | |
|---|---|---|---|
| | Ortho Nitraniline. | Meta Nitraniline. | Para Nitraniline. |
| 20 | ... | 1.14–1.67 | 0.77–0.80 |
| 24.2 | 1.25 (25°) | 1.205 | ... |
| 27.3 | ... | 1.422 | ... |

100 cc. $H_2O$ dissolve 2.2 gms. *p* nitraniline at 100°. (Jaeger and Kregten, 1912.)

100 gms. $H_2O$ dissolve 0.147 gm. o $C_6H_4NH_2NO_2$ at 30°. (Gross, Saylor and
" " " " 0.121 " m " " " " Gorman, 1933.)
" " " " 0.0728 " p " " " (Gross and Saylor, 1931)

### Solubility of Meta Nitraniline in Water.
(Walton and Finzel, 1928.)

Large volumes of water were saturated with m nitraniline at 15° - 20° above the temperature of the determinations and cooled to the desired temperature. A miniature Gooch asbestos filter was used to remove the finely suspended solid from the saturated solution. The authors found that saturation was reached quite slowly. The solutions were analyzed by the titanium tri chloride method and the sodium nitrite method.

| t° | Gms. m $C_6H_4NH_2NO_2$ per 100 gms. sat. sol. | t° | Gms. m $C_6H_4NH_2NO_2$ per 100 gms. sat. sol. |
|---|---|---|---|
| 0 | 0.030 | 44 | 0.211 |
| 10 | 0.047 | 55 | 0.338 |
| 20 | 0.073 | 65.4 | 0.543 |
| 25 | 0.091 | 75 | 0.838 |
| 35 | 0.141 | 83.4 | 1.23 |

## Solubility of o, m and of p Nitranilines in Water.

(Sidgwick and Rubie, 1921.)

The Synthetic method was used. Both the triple points and the critical solution temperatures, for the two liquid layers which separate, were determined. Asterisks indicate that a solid phase is present.

| Ortho Nitraniline. | | Meta Nitraniline. | | Para Nitraniline. | |
|---|---|---|---|---|---|
| t°. | Gms. *o* $NO_2C_6H_4NH_2$ per 100 gms. sat. sol. | t°. | Gms. *m* $NO_2C_6H_4NH_2$ per 100 gms. sat. sol. | t°. | Gms. *p* $NO_2C_6H_4NH_2$ per 100 gms. sat. sol. |
| 69.7 | 100.0 * | 114.6 | 100.0 * | 147.0 | 100.0 |
| 68.0 | 99.43* | 113.5 | 99.86* | 144.8 | 98.96 |
| 66.0 | 98.29* | 103.2 | 94.96* | 136.8 | 96.38 |
| 63.0 (tr. pt) | 97.5 * | 99.0 (tr. pt) | 93.5 * | 128.0 | 93.86 |
| 68.0 | 97.23 | 125.6 | 90.02 | 124.2 | 92.52 |
| 91.0 | 96.16 | 159.9 | 83.60 | 115.5 | 90.0 |
| 142.0 | 92.06 | 169.3 | 79.82 | 129.2 | 86.82 |
| 160.2 | 89.50 | 176.7 | 75.77 | 148.6 | 81.27 |
| 188.5 | 81.88 | 185.8 | 57.55 | 167.8 | 68.19 |
| 206.2 | 66.89 | 186.1 | 50.57 | 170.4 | 62.58 |
| 210.3 | 52.30 | 187.5 | (crit. sol. temp.) | 172.0 | 51.07 |
| 211.0 | (crit. sol. temp.) | 185.2 | 36.94 * | 172.5 | (crit. sol. temp.) |
| 208.6 | 36.71 | 180.5 | 25.34 | 172.0 | 39.49 |
| 194.2 | 17.50 | 164.2 | 13.08 | 169.5 | 28.82 |
| 178.5 | 10.74 | 136.5 | 6.04 | 141.5 | 9.29 |
| 164.5 | 7.19 | 83.4 | 1.70 * | 123.5 | 5.16 |
| 128.4 | 2.95 | | | 92.0 | 2.79* |

## Solubility of Ortho Meta and Para Nitraniline in Benzene.

(Sidgwick and Rubie, 1921.)

| Ortho Nitraniline. | | Meta Nitraniline. | | Para Nitraniline. | |
|---|---|---|---|---|---|
| t°. | Gms. *o* $NO_2C_6H_4NH_2$ per 100 gms. sat. sol. | t°. | Gms. *m* $NO_2C_6H_4NH_2$ per 100 gms. sat. sol. | t°. | Gms. *p* $NO_2C_6H_4NH_2$ per 100 gms. sat. sol. |
| 67.2 | 95.35 | 110.3 | 96.37 | 143.7 | 96.78 |
| 62.0 | 88.69 | 105.4 | 90.55 | 132.3 | 81.71 |
| 55.0 | 78.64 | 99.2 | 79.96 | 122.5 | 64.03 |
| 47.4 | 58.96 | 88.7 | 57.95 | 119.5 | 54.15 |
| 39.2 | 40.92 | 78.4 | 32.42 | 108.6 | 25.46 |
| 23.2 | 21.52 | 60.9 | 14.18 | 95.0 | 11.42 |
| 10.5 | 12.26 | 38.2 | 4.42 | 70.0 | 3.21 |

## Solubility of Ortho, Meta and Para Nitraniline in Several Solvents

(Collett and Johnson, 1926.)

| Solvent in each Case. | Solubility of: Ortho Nitraniline. Gms. *o* $NO_2C_6H_4NH_2$ per 100 gms. solvent. t°. | | Solubility of: Meta Nitraniline. Gms. *m* $NO_2C_6H_4NH_2$ per 100 gms. solvent. t°. | | Solubility of: Para Nitraniline Gms. *p* $NO_2C_6H_4NH_2$ per 100 gms. solv. t°. | |
|---|---|---|---|---|---|---|
| Water | 25.0 | 0.1212 | 25.0 | 0.0910 | 25.0 | 0.0568 |
| » | 40.1 | 0.2423 | 40.1 | 0.1785 | 40.1 | 0.1157 |
| Benzene | 25.0 | 20.80 | 25.0 | 2.718 | 25.0 | 0.5794 |
| » | .... | ..... | 40.1 | 5.137 | 40.1 | 1.050 |
| Ethyl alcohol (abs.) | .... | ..... | 0.0 | 4.035 | 0.0 | 3.382 |
| » | 25.0 | 27.87 | 25.0 | 7.778 | 25.0 | 6.048 |
| » | .... | ..... | .... | ..... | 40.1 | 8.234 |
| » (95 %) | .... | ..... | 25.0 | 7.155 | 25.0 | 5.674 |
| Chloroform | 0.0 | 11.17 | 0.0 | 1.358 | 0.0 | 0.4331 |
| » | ... | ..... | 25.0 | 3.216 | 25.0 | 0.929 |
| » | . | ..... | 40.1 | 6.102 | 40.1 | 1.559 |

## Solubility of Ortho and of Meta Nitraniline in Hydrochloric Acid.

(Lowenherz.)

| Ortho Nitraniline at 25°. | | | | Meta Nitraniline. | | | | |
|---|---|---|---|---|---|---|---|---|
| G. Mols. per Liter. | | Grams per Liter. | | | G. Mols. per Liter. | | Grams per Liter. | |
| HCl | $C_6H_4NH_2.NO_2(o)$ | HCl | $C_6H_4NH_2.NO_2(o)$ | | HCl | $C_6H_4NH_2.NO_2(m)$ | HCl | $C_6H_4NH_2.NO_2(m)$ |
| 0.0 | 0.0091 | 0.0 | 1.25 | (25°) | 0.0 | 0.0091 | 0.0 | 1.20 |
| 0.63 | 0.0143 | 22.97 | 1.97 | (26.5°) | 0.0125 | 0.0183 | 0.46 | 2.53 |
| 0.95 | 0.0174 | 34.63 | 2.40 | (23.3°) | 0.0247 | 0.0274 | 0.90 | 3.85 |
| 1.26 | 0.0215 | 45.94 | 2.97 | | | | | |

Data showing the effect of increasing amounts of several gum arabic sols upon the solubility of o, m and of p Nitraniline in Water are given by Brintzinger and Beier, 1934.

The coefficient of distribution at 25° of o nitraniline between water and heptane at concentrations varying from 0.00764 to 0.0119 gm. mols. per liter of the aqueous phase is 1.79. (Williams and Soper, 1930.)

## Solubility of Meta and of Para Nitraniline in Organic Solvents at 20°.

(Carnelly and Thomson.)

| Solvent. | Gms. per Liter. Meta. | Para. | Solvent. | Gms. per Liter. Meta. | Para. |
|---|---|---|---|---|---|
| Methyl Alcohol | 110.6 | 95.9 | Benzene | 24.5 | 19.8 |
| Ethyl Alcohol | 70.5 | 58.4 | Toluene | 17.1 | 13.1 |
| Propyl Alcohol | 56.5 | 43.5 | Cumene | 11.5 | 9.0 |
| Iso Butyl Alcohol | 26.4 | 19.1 | Chloroform | 30.1 | 23.1 |
| Iso Amyl Alcohol | 85.1 | 62.9 | Carbon Tetra Chloride | 2.1 | 1.7 |
| Ethyl Ether | 78.9 | 61.0 | Carbon Disulfide | 3.3 | 2.6 |

## Solubility of Ortho Nitraniline (m. pt. 69°.3) in Several Solvents.

(Collett and Johnston, 1926.)

Gm. mols. $o\,NO_2.C_6H_4NH_2$ per 100 gm. mols. saturated solution in

| t°. | Acetone. | Ethyl acetate. | Chloroform. | Benzene. | Ethyl ether. | Ethyl alcohol. | Carbon tetrachloride. | Nitro benzene. | Dibrom acetylene ($C_2Br_2$). |
|---|---|---|---|---|---|---|---|---|---|
| 25... | 40.0 | 34.1 | 23.0 | 10.5 | 18.7 | 8.5 | – | 24.8 (?) | 24.8 (?) |
| 30... | 44.6 | 38.3 | 28.4 | 13.6 | 21.5 | 10.4 | – | 29.0 | 29 0 |
| 40... | 54.5 | 48.2 | 42.0 | 27.6 | 30.6 | 18.7 | 4.6 | 39.8 | 39.8 |
| 50... | 65.6 | 61.6 | 60.0 | 51.6 | 50.1 | 40.3 | 21 1 | 56.4 | 56.4 |
| 60... | 79.2 | 77.6 | 77.3 | 75.8 | 74.0 | 74.0 | 73.9 | 76.0 | 76.0 |

100 gms. Carbon Tetrachlor. dissolve 1.18 gms. *o* Nitraniline at 20° (Pawlewski, 1914, 1926.)
100 gms. Chloroform dissolve 27.83 » » » » » »

100 gms. liquid ammonia dissolve 15 gms. o $C_6H_4NH_2NO_2$ at ? t°.
100 gms. liquid ammonia dissolve 10 gms. p $C_6H_4NH_2NO_2$ at ? t°.
100 gms. liquid sulfur dioxide dissolve 15 gms. $C_6H_4NH_2NO_2$ at ? t°.
(De Carli, 1927.)

## Solubility of Meta Nitraniline (m. pt. 111°.8) in Several Solvents.

(Collett and Johnston, 1926.)

| | Gm. mols. *m* $NO_2.C_6H_4.NH_2$ per 100 gm. mols saturated solution in | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| t°. | Acetone. | Ethyl acetate. | Chloro-form. | Benzene. | Ethyl alcohol. | Ethyl ether. | Carbon tetrachloride. | Nitro benzene | Dibrom acetylene. |
| 25.0..... | 19.5 | 16.1 | 2.6 | 1.5 | 2.4 | 3.6 | – | 11.3 | – |
| 30.0..... | 21.7 | 17.3 | 3.1 | 1.8 | 2.4 | 4,5 | – | 13.6 | – |
| 40.0..... | 26 3 | 20.0 | 4.4 | 2.8 | 4.1 | 6.3 | – | 16.7 | – |
| 50.0..... | 31.2 | 23.4 | 6.6 | 4.1 | 5.6 | 8 4 | – | 21.3 | 7.8 |
| 60.0..... | 36·9 | 28.2 | 10.8 | 7.2 | 8.5 | 11.3 | – | 27.0 | 12.5 |
| 70.0 ..... | 43.7 | 35.6 | 19.0 | 13.3 | 14.1 | 16.4 | – | 35.6 | 20.0 |
| 80.0..... | 52.4 | 46.0 | 33.1 | 25.2 | 25.8 | 25.9 | – | 46.0 | 33.0 |
| 90.0..... | 64.1 | 59.2 | 54.0 | 48.7 | 49.5 | 42.1 | 7.0 | 59.2 | 50.8 |
| 100.0..... | 78.9 | 76.0 | 73.3 | 72.7 | 73.0 | 68.6 | 86 7 | 76.0 | 73.7 |
| 110.0..... | 96.8 | 96.1 | 95.5 | 95.6 | 94.9 | 94.6 | – | 96.0 | 95.6 |

## Solubility of Para Nitraniline (m. pt. 147°.5) in Several Solvents.

(Collett and Johnson, 1926).

| | Gm. mol. *p* $NO_2.C_6H_4NH_2$ per 100 gms. mol. saturated solution in | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| t°. | Acetone. | Ethyl acetate. | Chloro-form. | Benzene. | Ethyl ether. | Ethyl alcohol. | Nitro benzene. | Dibrom acetylene. |
| 25..... | – | – | 0.8 | 0.3 | – | 2.0 | 6.7 | – |
| 30..... | – | – | 1.0 | 0.4 | – | 2.2 | 7.5 | – |
| 40..... | – | 11.4 | 1.3 | 0.6 | – | 2.9 | 9.3 | – |
| 50..... | 23.8 | 13.4 | 1.8 | 0.8 | – | 3.9 | 11.7 | – |
| 60..... | 26.5 | 15.8 | 2.5 | 1.2 | 3.4 | 5.1 | 14.9 | – |
| 70..... ..... | 29.7 | 18.8 | 3.8 | 1.7 | 3.8 | 6.6 | 19.3 | – |
| 80..... | 33.5 | 22.9 | 5.3 | 2.6 | 4.8 | 9.4 | 24.6 | 6.5 |
| 90..... | 38.6 | 28.6 | 8.8 | 4.3 | 5.7 | 15.3 | 31.2 | 11.0 |
| 100..... | 45.1 | 35.8 | 16.1 | 8.4 | 7 9 | 25.9 | 39.2 | 18.8 |
| 110..... | 53.2 | 44.6 | 29.8 | 16 8 | 12.7 | 39.2 | 48.6 | 30.9 |
| 120..... | 63.0 | 56.5 | 51.0 | 40.9 | 32.4 | 54.7 | 59.0 | 46.2 |
| 130..... .... | 88.8 | 87.1 | 86.5 | 84.8 | 85.6 | 87.5 | 87.1 | 84.8 |

The results in the above tables for the solvents Nitrobenzene and Dibromacetylene are taken from the paper of Bogojavlewski, Bogolinbov and Vinogradov

(Chem. Abs, 1, 2874, 1907.)

## Solubility of *o*, *m* and *p* Nitraniline, Separately, in Para Cymene and in Xylene

| Solvent. | t°. | Gms. of each compound per 100 gms. solvent. *o* $NO_2.C_6H_4NH_2$. | *m* $NO_2.C_6H_4NH_2$. | *p* $NO_2.C_6H_4NH_2$. | Authority. |
|---|---|---|---|---|---|
| Para Cymene (b. pt. 176°-176°,5)..... | 30 | 6.33 | 1.36 | 0.83 | (Wheeler, 1920.) |
| *m* Xylene ..... | 15 | 11.6 | 1.74 | 0.28 | (Chapas, 1921.) |

Freezing-point data are given for mixtures of Nitranilines and:

Acetanilide(2)
Benzene(1)
Chloro dinitro benzene(3)
Dianisol acetone(21)
Dinitro benzenes(2)(8)
Ethylene bromide(1)
Naphthalene(16)
Nitracetanilide(4)
Nitranilines(9)(10)(11)(12)(13)(19)(20)(25)
Michler's Ketone(15)
Nitro benzene(1)
Nitro mannite(22)
Nitro chloro benzene(24)
Nitro phenol(24)
Nitro toluene(24)
Nitroso aniline(5)
Phenol(14)
Styphnic acid(6)
Tetra methyl di amino benzo phenone(21)
Tri nitro benzene(17)(18)
Tri nitro anisole(23)
Tri nitro phenyl methyl nitramine(7)

(1) Bogojawlensky, Winogradow and Bogolubow, 1906; (2) Crompton and Whiteby, 1895; (3) Giua, Marcellino and Curti, 1920; (4) Jaeger, 1906; (5) Jaeger and Van Kregten, 1912; (6) Jefremow, 1927; (7) Jefremow and Tichomirowa, 1926; (8) Johnston and Jones, 1928; (9) Hartogs and Van der Linden, 1911; (10) Holleman, Hartogs and Van der Linden, 1911; (11) Kohman, 1925; (12) Kremann, 1910; (13) Kremann, Geba and Moss, 1910; (14) Kremann and Rodinis, 1906; (15) Pfeiffer, 1924; (16) Puschin and Grebenschikov, 1913; (17) Smith and Watts, 1910; (18) Sudborough and Beard, 1910; (19) Nichols, 1918; (20) Valeton, 1910; (21) Pfeiffer, Goebel and Angern, 1925; (22) Urbanski, 1934; (23) Giua, 1931; (24) Grimm, Gunther and Titus, 1931; (25) Hertel and Römer, 1930.

**PYROGALLOL** $C_6H_3(OH)_3$ 1, 2, 3.

SOLUBILITY IN WATER, ETC.
(U. S. P. VIII.)

100 gms. water dissolve 62.5 gms. $C_6H_3(OH)_3$ at 25°.
100 gms. alcohol dissolve 100 gms. $C_6H_3(OH)_3$ at 25°.
100 gms. ether dissolve 90.9 gms. $C_6H_3(OH)_3$ at 25°.

SOLUBILITY OF PYROGALLOL IN AQUEOUS SOLUTIONS OF HYDROCHLORIC ACID AT 25°.
(Knox and Richards, 1919.)

| Equiv. Normality. | | Equiv. Normality. | | Equiv. Normality. | |
|---|---|---|---|---|---|
| HCl. | $C_6H_3(OH)_3$. | HCl. | $C_6H_3(OH)_3$. | HCl. | $C_6H_3(OH)_3$. |
| 0.0 | 4.02 | 5.12 | 1.25 | 10.43 | 0.92 |
| 1.53 | 2.81 | 6.86 | 1.01 | 10.48 | 0.93 |
| 3.18 | 1.86 | 8.68 | 0.91 | | |

Freezing-point data for mixtures of Pyrogallol and:

Acetamide(16)
Acetone(21)
Aceto phenone(8)
Amino phenol(9)
Aniline(16)
Antipyrine(7)
Azo benzene(19)
Benzamide(16)
Benz hydrol(4)
Benzo phenone(16)
Camphor(2)(12)
Carbazole(13)
Cinnamic acid(17)
Di methyl oxalate(17)
Di phenyl amine(15)
" " methane(6)
Fenchon(5)
Nitro benzene(14)
Naphthylamines (16)
Oxy benzaldehyde(10)
Phenylene diamine(1)(16)(20)
Quinone(14)
Salicylaldehyde(16)
Succinic acid(17)
Succinimide(5)
Toluidine(16)
Tri phenyl methane(18)
Tri chloro acetic acid(3)

(1) Betts, 1937; (2) Journiaux, 1912; (3) Kitran, 1924; (4) Kremann and Drazil, 1924; (5) Kremann and Dietrich, 1922; (6) Kremann and Fritsch, 1920; (7) Kremann and Haas, 1919; (8) Kremann and Marktl, 1920; (9) Kremann, Lupfer and Zawodsky, 1920; (10) Kremann and Pogantsch, 1923; (11) Kremann, Hohl and Müller II, 1921; Kremann and Odelga, 1921; (13) Kremann and Slovak, 1920; (14) Kremann, Sutter, Sitte, Strzelba and Dobolsky, 1922; (15) Kremann and Schadinger, 1919; (16) Kremann and Zechner, 1918, 1925; (17) Kremann, Zechner and Drazil, 1924; (18) Kremann, Odelga and Zawodsky, 1921; Kremann, Zechner and Weber, 1924; (20) Naegli and Kaltaman, 1933; (21) Schmidlin and Lang, 1910.

**PHLOROGLUCINOL** 1.3.5 $C_6H_3(OH)_3.2H_2O$.

100 gms. Cymene dissolve 0.12 gm. $C_6H_3(OH)_3$ at 175°. (Wheeler, 1920.)

100 gms. $H_2O$ dissolve 1.13 gms. phloroglucinol at 20-25°. (Dehn, '17.)
" pyridine " 296 " " " " "
" aq. 50% pyridine " 134

Freezing-point data for mixtures of phloro glucinol and p phenylene diamine are given by Naegli and Koltman, 1933.

## Oxymethyl **FURFURAL** $C_6H_6O_3$.

### Freezing-Points of Mixtures of Oxymethyl Furfural and Water.

(Middendorp. 1919.)

The compound was shown to have the structural formula $HO.H_2C-C_4H_2O-C.OH$.

It distills at 114-116°, at 1 mm. pressure, yielding a liquid of $d_{\frac{15}{15}} = 1.268$. At very low temperatures it yields crystals of m. pt. 31°.5. It is soluble in all proportions in water. The following results for the f. pts. of its mixtures with water were obtained.

| t° of f. pt. | Mol. per cent $C_6H_6O_3$ in mixture. | t° of f. pt. | Mol. per cent $C_6H_6O_3$ in mixture | t° of f. pt. | Mol. per cent $C_6H_6O_3$ in mixture. |
|---|---|---|---|---|---|
| 31.5..... | 100 | 9.85..... | 52.2 | —4.5 (Eutec.). | 21.3 |
| 27.0..... | 90.8 | 8.95..... | 49.9 | —3.25..... | 17.8 |
| 24.3..... | 84 | 7.35..... | 46.4 | —2.95..... | 15.3 |
| 20.2..... | 75 | 4.55..... | 41.6 | —2.4..... | 11.1 |
| 17.6..... | 69.1 | 3.55..... | 38.0 | —2.24..... | 9.4 |
| 15.2..... | 64.1 | 1.6..... | 34.6 | —1.5..... | 5.0 |
| 13.05..... | 59.4 | —0.4..... | 30.9 | 0.0..... | 0.0 |
| 10.95..... | 55.4 | —2.2..... | 25.9 | | |

## *p* Brom**ANILINE** *o* Sulfonic Acid, $p\,BrC_6H_3(NH_2), o\,SO_3H$.

### Solubility in Water (Philip and Colborne, 1924.)

| t°. | Gms. $BrC_6H_3(NH_2)SO_3H$ per 100 gms. sat. sol. | Solid Phase. | t°. | Gms. $BrC_6H_3(NH_2)SO_3H$ per 100 gms. sat. sol. | Solid Phase. |
|---|---|---|---|---|---|
| 0.0... | 0.223 | $BrC_6H_3(NH_2)SO_3H$ | 70..... | 1.375 | $BrC_6H_3(NH_2)SO_3H$ |
| 8.35.. | 0.279 | » | 85..... | 2.02 | » |
| 16.75.. | 0.359 | » | 0.0... | 0.259 | $BrC_6H_3(NH_2)SO_3H.H_2O$ |
| 25.0... | 0.446 | » | 8.35.. | 0.352 | » (unstable) |
| 40.0... | 0.650 | » | 16.8... | 0.473 | » » |
| 55.0... | 0.965 | » | 25.0... | 0.606 | » » |

## *p* Brom**ANILINE** *m* Sulfonic Acid, $p\,BrC_6H_3(NH_2)\,m\,SO_3H$.

### Solubility in Water.

(Philip and Colborne, 1924.)

This compound exists in two enantiotropic forms. It also forms a labile monohydrate.

| t°. | Gms. $BrC_6H_3(NH_2)SO_3H$ per 100 gms. sol. sat. | Solid Phase. | t°. | Gms. $BrC_6H_3(NH_2)SO_3H$ per 100 gms. sat. sol. | Solid Phase. |
|---|---|---|---|---|---|
| 0.0... | 0.726 | $BrC_6H_3(NH_2)SO_3H$ (rhombic) | 0.0... | 0.475 | $BrC_6H_3(NH_2)SO_3H$ (monoclinic) |
| 9.8... | 0.885 | » » | 12.55.. | 0.645 | » » |
| 25.0... | 1.198 | » » | 25.0... | 0.862 | » » |
| 40.1... | 1.610 | » » | 40.0... | 1.215 | » » |
| 54.8... | 2.10 | » » | 56.3... | 1.790 | » » |
| 70.4... | 2.81 | » » | 70.0... | 2.44 | » » |
| 85.0... | 3.66 | » » | 85.0... | 3.35 | » » |

### Solubility of Chlor Aniline Sulfonic Acids, in Water.

(Philip and Colborne, 1924.)

| Compound. | Formula. | t°. | Gms. anhydrous cmpd. per 100 gms. sat. sol. | Solid Phase. |
|---|---|---|---|---|
| *p* Chloraniline *o* sulfonic acid. | $pClC_6H_3NH_2\,o\,SO_3H$ | 0 | 0.313 | $pClC_6H_3NH_2\,o\,SO_3H.H_2O$ |
| *p* » *m* » . | $pClC_6H_3NH_2\,m\,SO_3H$ | 0 | 1.131 | $pClC_6H_3NH_2\,m\,SO_3H$ |
| *p* » *m* » . | » | 0 | 1.160 | $pClC_6H_3NH_2\,m\,SO_3H.H_2O$ |

## Iodo**ANILINE** Sulfonic Acids, $IC_6H_3(NH_2)SO_3H$.

SOLUBILITY OF EACH IN WATER AT 25°. (Boyle, 1919.)

| Compound. | Formula. | Gms. cmpd. per 100 gms. $H_2O$. |
|---|---|---|
| 4 Iodo aniline 2 sulfonic acid... | $C_6H_3NH_2(1)I(4)SO_3H(2)$ | 0.51 |
| 5 » 2 » ... | $C_6H_3NH_2(1)I(5)SO_3H(2)$ | 0.26 |
| 4 » 3 » ... | $C_6H_3NH_2(1)I(4)SO_3H(3)$ | 1.36 |
| 5 » 3 » ... | $C_6H_3NH_2(1)I(5)SO_3H(3)$ | 1.31 |
| 6 » 3 » ... | $C_6H_3NH_2(1)I(6)SO_3H(3)$ | 0.48 |
| 2 » 4 » ... | $C_6H_3NH_2(1)I(2)SO_3H(4)$ | 2.07 |
| 3 » 4 » ... | $C_6H_3NH_2(1)I(3)SO_3H(4)$ | 0.194 |

## **ACONITIC ACID** $C_3H_3(COOH)_3$.

100 grams of formic acid (95% HCOOH) dissolve 2.01 grams $C_3H_3(COOH)_3$ at 20.6° C. (Aschan, 1913.)

## **ALLOXANTIN** $C_6H_6O_8N_4.2H_2O$.

SOLUBILITY IN WATER AND IN AQUEOUS SOLUTIONS OF ALLOXAN AT 25°
(Biillmann and Bentzon, 1918.)

Oxygen was excluded during the determinations by the use of $CO_2$. Aqueous solutions rotated from 3.8 to 5.5 hours gave practically identical results. The solutions were analyzed by estimations of total nitrogen and alloxantin nitrogen determined colorimetrically. The solubility of alloxantin in water at 25° was found to be 0.2885 gms. $C_6H_6O_8N_4.2H_2O$ per 100 gms. sat. solution. The solubility in aqueous solutions of alloxan was as follows.

| Grams per 100 grams sat. solution. | | Gm. mols. $\times 10^{-4}$ per 100 gms. sat. sol. | |
|---|---|---|---|
| Alloxan nitrogen. | Alloxantin nitrogen. | Alloxan. | Alloxantin. |
| 0.0023 | 0.0487 | 0.82 | 8.69 |
| 0.0032 | 0.0475 | 1.14 | 8.49 |
| 0.0045 | 0.0458 | 1.61 | 8.19 |
| 0.0054 | 0.0455 | 1.93 | 8.12 |
| 0.0112 | 0.0412 | 4.00 | 7.35 |
| 0.0197 | 0.0363 | 7.03 | 6.50 |
| 0.0258 | 0.0335 | 9.20 | 5.98 |
| 0.0409 | 0.0278 | 14.6 | 4.98 |
| 0.0773 | 0.0219 | 27.6 | 3.91 |
| 0.0827 | 0.0204 | 29.5 | 3.64 |
| 0.0869 | 0.0200 | 31.0 | 3.59 |
| 0.1140 | 0.0177 | 40.7 | 3.18 |
| 0.1606 | 0.0151 | 57.3 | 2.68 |

## **ANILINE** $C_6H_5(NH_2)$.

SOLUBILITY IN WATER AT 22°.
(Herz, 1898; see also Vaubel, 1895; Aignan and Dugas, 1899.)

100 cc. $H_2O$ dissolve 3.481 cc. $C_6H_5(NH_2)$ — Vol. of Sol. = 103.48, Sp. Gr. = 0.9986.

100 cc. $C_6H_5(NH_2)$ dissolve 5.22 cc. $H_2O$ — Vol. of Sol. = 104.96, Sp. Gr. = 1.0175.

100 cc. sat. aq. sol. contain 3.607 gms. $C_6H_5NH_2$ at 25°. (Riedel, 1906.)

SOLUBILITY OF ANILINE IN WATER DETERMINED BY THE SYNTHETIC METHOD.
(Sidgwick, Pickford and Wilsden, 1911.)

| t° | Gms. $C_6H_5NH_2$ per 100 gms. aq. layer | Gms. $H_2O$ per 100 gms. $C_6H_5NH_2$ layer |
|---|---|---|
| 13.8 | 3.611 | 5.12 (20°) |
| 30 | 3.7 | 5.4 |
| 50 | 4.2 | 6.4 |
| 70 | 5 | 7.7 |
| 90 | 6.4 | 9.9 |
| 110 | 8 | 13 |
| 120 | 9.1 | 14.6 |
| 130 | 11.2 | 16.9 |
| 140 | 13.5 | 19.5 |
| 150 | 17.1 | 24 |
| 160 | 22 | 32 |
| 165 | 26.1 | |

### Solubility of Water in Aniline, Determined by the Synthetic Method.

(Appleby and Davies, 1925.)

| t°. | Gms. $H_2O$ per 100 gms. sat. sol. | t°. | Gms. $H_2O$ per 100 gms. sat. sol. | t°. | Gms. $H_2O$ per 100 gms. sat. sol. |
|---|---|---|---|---|---|
| 15.9..... | 4.534 | 20.5..... | 4.815 | 34.1..... | 5.398 |
| 18.3..... | 4.659 | 21.15.... | 4.926 | 43.5..... | 5.899 |
| 20.0..... | 4 835 | 22.6..... | 4.950 | 47.5..... | 6.104 |

100 gms. sat. sol. of Aniline in water contain 3.66 gms. $C_6H_5NH_2$ at 25°.
" " " " " Water in aniline " 5.22 " $H_2O$ at 25°.
(Hill and Macy, 1924.)

Determinations of the densities of each of the two layers formed by mixtures of aniline and water between 20° and 100° are given in the form of a diagram by Mondain-Monval and Schlegel, 1933. The two curves cross at 77° and below this temperature the aniline rich layer is the lower and above the aniline rich layer is the upper. At 77° the two layers have the same density.

### Reciprocal Solubility of Aniline and Water Determined by the Freezing-Point Method.

(Average curve from the results of Hill and Macy, 1924, and Appleby and Davies, 1925.)

| t°. | Gms. $C_6H_5NH_2$ per 100 gms. sat. sol. | Solid Phase. | t°. | Gms. $C_6H_5NH_2$ per 100 gms. sat. sol. | Solid Phase. |
|---|---|---|---|---|---|
| —0.1..... | 0.5 | Ice | — 7.0..... | 96.32 | Ice |
| —0.2..... | 1.0 | » | — 9.0..... | 96.7 | » |
| —0.3..... | 1.55 | » | —11.0..... | 97.05 | » |
| —0.4..... | 2.07 | » | —11.9 (b.t.)... | 97.25 | » + $C_6H_5NH_2$ |
| —0.5..... | 2.6 | » | —11.0..... | 97.85 | $C_6H_5NH_2$ |
| —0.66..... | 3.5 | » (quad. pt.) | —10.0..... | 98.4 | » |
| congruent solutions here | | | — 9.0..... | 98.9 | » |
| —0.66..... | 95.4 | » (quad. pt.) | — 8.0..... | 99.35 | » |
| —3.0..... | 95.7 | » | — 7.0..... | 99.7 | » |
| —5.0..... | 96.0 | » | — 6.0..... | 100.0 | » |

Using an optical method, Chéneveau (1922) found that 100 gms. of $H_2O$ dissolve 3.73 gms. aniline at 16° and 100 gms. aniline dissolve 4.68 gms. $H_2O$ at 15°.

### Solubility of Aniline in Aqueous Salt Solutions at 18°.

(Euler — Z. physik. Chem. 49, 307, '04.)

| Aq. Solution. | Gms. Salt per liter. | Gms. $C_6H_5(NH_2)$ per 100 g. solvent. | Aq. Solution. | Gms. Salt per liter. | Gms. $C_6H_5(NH_2)$ per 100 g. solvent. |
|---|---|---|---|---|---|
| $H_2O$ alone | 0 | 3.61 | 1 *n*NaOH | 40.06 | 1.90 |
| 0.5 *n*KCl | 37.3 | 3.15 | 1 *n*LiCl | 42.48 | 2.80 |
| 1 *n*KCl | 74.6 | 2.68 | 1 *n*$CaCl_2$ | 67.25 | 3.00 |
| 1 *n*NaCl | 58.5 | 2.55 | | | |

### Solubility of Aniline in Aqueous Solutions of Salts at 18°.

(von Euler and Svanberg, 1917, 1917*a*, 1926.)

| Aqueous solvent. | Gms. $C_6H_5NH_2$ per 100 cc. sat. sol. | Aqueous solvent. | Gms. $C_6H_5NH_2$ per 100 cc. sat. sol. |
|---|---|---|---|
| Water..... | 3.61 | 1.0 normal Na salicylate... | 7.14 |
| 1.0 normal NaCl..... | 2.55 | 2.0 » K valerate..... | 3.37 |
| 1.0 » Na acetate.... | 2.32 | 2.0 » K isovalerate.... | 3.37 |
| 1.0 » Na butyrate .. | 2.53 | 0.5 » Aniline chloride. | 4.60 |
| 1.0 » Na isovalerate. | 1.88 | 1.0 » » » . | 5.30 |
| 1.0 » Na benzoate... | 3.80 | 0.5 » Aniline nitrate.. | 4.60 |
| 1.0 » $NH_4$ benzoate. | 4.60 | 1.0 » » » .. | 5.25 |

Determinations of the solubility of aniline in saturated aqueous solutions of sodium benzene sulfonate, sodium xylene sulfonate and sodium cymene sulfonate at various temperatures are given by Hauslick, 1935.

100 gms. aq. 0.4 normal sodium Oleate solution (= 10.8 gm. Na oleate per 100 gms. solution)dissolve 11.5 gms. $C_6H_5NH_2$ at 20°. (Smith, 1932.)

## Solubility of Aniline in Aqueous Solutions of Salts.

(Glasstone, Bridgeman and Hodgson, 1927.)

The authors' original results are in terms of gm. mols. of salt and of water required to yield a homogeneous mixture with 1 gm. mol. of aniline. The following weight percentage values are those recalculated for the Landoldt and Bornstein Tabellen.

| t° | Salt | Gms. per 100 gms. sat. sol. Salt | Gms. per 100 gms. sat. sol. $C_6H_5NH_2$ |
|---|---|---|---|
| 25 | $BaCl_2$ | 1.66 | 3.43 |
| " | " | 2.90 | 3.26 |
| " | " | 3.48 | 3.18 |
| " | " | 7.00 | 2.75 |
| " | " | 14.26 | 1.98 |
| " | $Ba(NO_3)_2$ | 0.93 | 3.68 |
| " | " | 1.91 | 3.58 |
| " | " | 2.85 | 3.50 |
| " | " | 3.86 | 3.44 |
| " | " | 4.85 | 3.39 |
| " | CsCl | 4.79 | 3.58 |
| " | " | 19.34 | 2.98 |
| " | " | 44.70 | 1.95 |
| 50 | " | 4.79 | 4.01 |
| " | " | 19.06 | 3.09 |
| " | " | 44.71 | 1.94 |
| 25 | KCl | 1.96 | 3.30 |
| " | " | 4.84 | 2.86 |
| " | " | 9.73 | 2.28 |
| " | " | 14.71 | 1.76 |
| " | " | 24.75 | 0.99 |
| 50 | " | 1.93 | 3.77 |
| " | " | 4.82 | 3.15 |
| " | " | 9.72 | 2.46 |
| " | " | 19.71 | 1.46 |
| 25 | KBr | 1.91 | 3.48 |
| " | " | 4.80 | 3.23 |
| " | " | 9.69 | 2.88 |
| " | " | 20.16 | 2.29 |
| " | " | 39.51 | 1.12 |
| 50 | " | 1.89 | 4.00 |
| " | " | 9.65 | 3.21 |
| " | " | 19.75 | 2.47 |
| " | " | 39.47 | 1.22 |
| 25 | KI | 1.90 | 3.56 |
| " | " | 4.84 | 3.52 |
| " | " | 9.64 | 3.40 |
| " | " | 19.53 | 3.02 |
| " | " | 59.06 | 1.46 |
| 50 | " | 1.95 | 4.05 |
| " | " | 4.84 | 3.93 |
| " | " | 19.39 | 3.54 |
| " | " | 59.01 | 1.59 |
| 25 | $KNO_3$ | 1.92 | 3.54 |
| " | " | 4.83 | 3.32 |
| " | " | 9.71 | 2.94 |
| " | " | 14.63 | 2.53 |
| " | " | 19.59 | 2.17 |
| 25 | CsBr | 4.79 | 3.74 |
| " | " | 19.35 | 3.57 |
| " | " | 43.53 | 3.25 |
| 50 | " | 4.75 | 4.24 |
| " | " | 19.26 | 3.81 |
| " | " | 43.56 | 3.22 |
| 25 | CsI | 5.58 | 4.00 |
| " | " | 19.21 | 4.02 |
| " | " | 33.51 | 4.62 |
| 50 | " | 5.41 | 4.40 |
| " | " | 19.17 | 4.52 |
| " | " | 33.54 | 4.73 |
| 25 | KF | 1.94 | 2.91 |
| " | " | 4.89 | 2.04 |
| " | " | 9.87 | 1.12 |
| " | KOH | 1.96 | 3.07 |
| " | " | 4.90 | 2.20 |
| " | " | 9.87 | 1.25 |
| " | " | 19.92 | 0.422 |
| " | " | 35.00 | 0.055 |
| " | " | 49.96 | 0.020 |
| " | $K_2CrO_4$ | 1.97 | 3.25 |
| " | " | 4.97 | 2.70 |
| " | " | 9.81 | 2.02 |
| " | " | 18.95 | 1.08 |
| " | " | 29.83 | 0.47 |
| " | $K_2SO_4$ | 0.96 | 3.40 |
| " | " | 1.95 | 3.16 |
| " | " | 3.87 | 2.72 |
| " | " | 7.84 | 2.00 |
| " | $K_4Fe(CN)_6$ | 2.02 | 2.68 |
| " | " | 4.41 | 2.79 |
| " | " | 8.85 | 2.15 |
| " | " | 17.71 | 1.25 |
| " | $CH_3COOK$ | 1.94 | 3.35 |
| " | " | 4.83 | 2.98 |
| " | " | 9.76 | 2.37 |
| " | " | 19.70 | 1.58 |
| " | " | 39.01 | 1.23 |
| " | " | 49.72 | 0.57 |
| " | $(COOK)_2$ | 1.97 | 3.14 |
| " | " | 4.87 | 2.53 |
| " | " | 9.71 | 1.86 |
| " | $KClO_3$ | 0.95 | 3.59 |
| " | " | 1.94 | 3.50 |
| " | " | 2.86 | 3.45 |
| " | " | 3.83 | 3.38 |
| " | " | 4.85 | 3.22 |

SOLUBILITY OF ANILINE IN AQUEOUS SOLUTIONS OF SALTS (CON.).

| t° | Salt | Gms. per 100 gms. sat. sol. Salt | Gms. per 100 gms. sat. sol. $C_6H_5NH_2$ |
|---|---|---|---|
| 25 | $K_2CO_3$ | 1.94 | 3.11 |
| " | " | 4.98 | 2.27 |
| " | " | 9.85 | 1.35 |
| " | " | 19.89 | 0.38 |
| " | " | 34.87 | 0.047 |
| " | LiCl | 1.95 | 3.37 |
| " | " | 17.94 | 1.22 |
| " | " | 39.22 | 0.37 |
| 50 | " | 1.94 | 3.88 |
| " | " | 19.71 | 1.37 |
| " | " | 39.20 | 0.43 |
| 25 | LiBr | 1.91 | 3.80 |
| " | " | 19.39 | 3.01 |
| " | " | 58.74 | 1.72 |
| 50 | " | 1.90 | 4.25 |
| " | " | 19.32 | 3.26 |
| " | " | 58.70 | 1.83 |
| 25 | LiI | 1.89 | 3.87 |
| " | " | 9.58 | 3.94 |
| " | " | 31.92 | 4.62 |
| 50 | " | 1.90 | 4.39 |
| " | " | 9.57 | 4.38 |
| " | " | 31.89 | 4.81 |
| 25 | $MgSO_4$ | 1.89 | 3.11 |
| " | " | 4.97 | 2.37 |
| " | " | 9.86 | 1.52 |
| " | " | 13.59 | 0.35 |
| " | $NH_4Cl$ | 2.09 | 3.46 |
| " | " | 9.73 | 2.91 |
| " | " | 19.83 | 2.47 |
| 50 | " | 2.08 | 3.81 |
| " | " | 9.72 | 3.12 |
| " | " | 19.49 | 2.47 |
| 25 | $NH_4Br$ | 1.97 | 3.83 |
| " | " | 19.01 | 3.45 |
| " | " | 38.51 | 3.09 |
| 50 | " | 1.96 | 4.33 |
| " | " | 19.24 | 3.84 |
| " | " | 38.74 | 3.30 |
| 25 | $NH_4I$ | 1.96 | 3.70 |
| " | " | 19.11 | 4.35 |
| " | " | 57.0 | 5.01 |
| 50 | " | 1.96 | 4.19 |
| " | " | 18.98 | 5.06 |
| " | " | 56.53 | 5.81 |
| 25 | $(COONH_4)_2$ | 0.96 | 3.42 |
| " | " | 1.88 | 3.20 |
| " | " | 2.91 | 2.99 |
| " | " | 13.97 | 2.59 |
| " | NaCl | 1.90 | 3.18 |
| " | " | 4.87 | 2.56 |
| " | " | 9.74 | 1.85 |
| " | " | 15.08 | 1.25 |
| " | " | 25.01 | 0.543 |
| 50 | NaCl | 4.86 | 2.91 |
| " | " | 9.72 | 2.08 |
| " | " | 19.85 | 1.993 |
| 25 | NaBr | 1.90 | 3.50 |
| " | " | 4.64 | 3.25 |
| " | " | 9.71 | 2.77 |
| " | " | 29.59 | 1.46 |
| " | " | 44.64 | 0.68 |
| 50 | " | 1.91 | 3.93 |
| " | " | 9.69 | 3.13 |
| " | " | 29.58 | 1.56 |
| 25 | NaI | 1.85 | 3.85 |
| " | " | 4.84 | 3.45 |
| " | " | 9.68 | 3.34 |
| " | " | 39.04 | 2.39 |
| " | " | 56.37 | 1.17 |
| 50 | " | 1.83 | 4.05 |
| " | " | 4.79 | 3.91 |
| " | " | 59.20 | 1.44 |
| 25 | $NaNO_3$ | 1.94 | 3.42 |
| " | " | 4.83 | 3.17 |
| " | " | 9.83 | 2.70 |
| " | " | 19.60 | 1.80 |
| " | " | 39.74 | 0.59 |
| " | $Na_2SO_4$ | 1.94 | 3.02 |
| " | " | 4.91 | 2.22 |
| " | " | 9.75 | 1.33 |
| " | " | 14.79 | 0.73 |
| " | Na citrate | 1.91 | 3.13 |
| " | " | 4.90 | 2.49 |
| " | " | 11.98 | 2.07 |
| " | " | 19.86 | 0.74 |
| " | " | 24.76 | 0.47 |
| " | RbCl | 4.86 | 3.31 |
| " | " | 19.48 | 2.08 |
| " | " | 44.70 | 0.86 |
| 50 | " | 4.84 | 3.73 |
| " | " | 19.41 | 2.26 |
| " | " | 44.63 | 0.90 |
| 25 | RbBr | 4.76 | 3.57 |
| " | " | 19.31 | 2.86 |
| " | " | 49.06 | 1.41 |
| 50 | " | 4.76 | 4.06 |
| " | " | 19.27 | 3.08 |
| " | " | 49.03 | 1.49 |
| 25 | RbI | 4.77 | 3.80 |
| " | " | 19.39 | 3.69 |
| " | " | 43.58 | 3.28 |
| 50 | " | 4.80 | 4.29 |
| " | " | 19.32 | 3.99 |
| " | " | 43.53 | 3.42 |
| 25 | $Sr(NO_3)_2$ | 1.96 | 3.58 |
| " | " | 4.16 | 3.42 |
| " | " | 9.69 | 3.15 |
| " | " | 19.49 | 2.69 |
| " | " | 39.42 | 1.47 |

The author also gives similar results for the solubility of aniline in a number of pairs of salts.

## Solubility of Aniline in Aqueous Solutions of Salts at 18.15°.

(Pedersen, 1934.)

Results for aqueous solutions of:

| Sodium Picrate | | Sodium Benzoate | | Anilinium Sulfate | | Potassium Sulfate | |
|---|---|---|---|---|---|---|---|
| Gm. Equiv $C_6H_2(NO_2)_3ONa$ per liter | Gm. Mols. $C_6H_5NH_2$ per liter | Gm. Equiv. $C_6H_5COONa$ per liter | Gm. Mols. $C_6H_5NH_2$ per liter | Gm. Equiv. $(C_6H_5NH)_2SO_4$ per liter | Gm. Mols. $C_6H_5NH_2$ per liter | Gm. Equiv. $K_2SO_4$ per liter | Gm. Mols. $C_6H_5NH_2$ per liter |
| 0.000 | 0.3818 | 0.0000 | 0.3818 | 0.0289 | 0.3791 | 0.000 | 0.3818 |
| 0.0297 | 0.4058 | 0.0659 | 0.3833 | 0.0356 | 0.3792 | 0.0483 | 0.3589 |
| 0.0594 | 0.4303 | 0.1318 | 0.3827 | 0.0968 | 0.3792 | 0.0970 | 0.3384 |
| 0.0889 | 0.4554 | 0.1977 | 0.3841 | 0.1417 | 0.3829 | 0.1456 | 0.3197 |
| 0.1181 | 0.8820 | 0.2636 | 0.3850 | 0.1912 | 0.3839 | 0.1948 | 0.3012 |

## Solubility of Anilinium Sulfate in Aqueous Solutions of Aniline at 18.15°.

(Pedersen, 1934.)

| Gm. Equivalents of $C_6H_5NH_2$ per liter | Gm. Mols. $(C_6H_5NH_2)_2H_2SO_4$ per liter of sat. solution |
|---|---|
| 0.0000 | 0.2038 |
| 0.0298 | 0.2014 |
| 0.1444 | 0.2015 |
| 0.2905 | 0.2019 |

## Solubility of Anilinium Picrate at 18.15° in Aqueous Solutions of:

(Pedersen, 1934.)

| 0.00993 n HCl containing NaCl | | Aniline | |
|---|---|---|---|
| Gm. Mols. NaCl per liter solvent | Gm. Mols $C_6H_5NH_2 \cdot OHC_6H_2(NO_2)_3$ per liter sat. solution | Gm. Equiv. $C_6H_5NH_2$ per liter solvent | Gm. Mols. $C_6H_5NH_2 \cdot HOC_6H_2(NO_2)_3$ per liter sat. solution |
| 0.000 | 0.01200 | 0.0000 | 0.01176 |
| 0.0100 | 0.01234 | 0.0513 | 0.01225 |
| 0.0200 | 0.01258 | 0.0990 | 0.01299 |
| 0.0400 | 0.01297 | 0.1535 | 0.01386 |
| 0.0800 | 0.01344 | 0.2050 | 0.01472 |
| | | 0.2524 | 0.01554 |

Anilinium picrate exists in both an unstable form (resembling picric acid in color) and a stable form (resembling potassium picrate). The solubility determinations were made with the stable form.

## Solubility of Aniline in Aqueous Solutions of:

(Traube, Schöning and Weber, 1927.)

| Sodium Benzoate | | Sodium Salicylate | | Sodium Butyrate | |
|---|---|---|---|---|---|
| Conc. of aq. salt sol. | cc $C_6H_5NH_2$ per 5cc of aq. salt sol. | Conc. of aq. salt sol. | cc $C_6H_5NH_2$ per 5cc of aq. salt.sol. | Conc. of aq. salt sol. | cc $C_6H_5NH_2$ per 5cc of aq. salt sol. |
| 0.0 | 0.15 | ¼ saturated | 0.3 | 0.0 | 0.15 |
| 2.0 normal | 0.6 | ½ saturated | 2.8 | saturated | 0.15 |
| saturated | 1.8 | " | ∞ | | |

## Solubility of Aniline in Aqueous Solutions of Aniline Hydrochloride.

(Sidgwick, Pickford and Wilsden, 1911.)

The temperatures at which a second liquid phase separated from homogeneous mixtures of known amounts of aniline + HCl + $H_2O$ were determined for a very extensive series of mixtures. The procedure consisted in first heating a given mixture until it became homogeneous and then cooling it slowly, with constant shaking. A critical turbidity preceding the actual separation by a few degrees was always noticed. The point of separation was taken as that at which a small gas flame seen through the liquid disappeared. At higher temperatures, the observations were made on mixtures contained in sealed bulbs. In the actual experiments, binodal curves for mixtures of Aq. HCl (of different strengths) and aniline were determined. By interpolation from these, the following isothermal curves were obtained.

Isotherm for 15°.

| $H_2O$ Rich Mixtures. Gms. per 100 Gms. Sat. Solution. | | Aniline Rich Mixtures. Gms. per 100 Gms. Sat. Solution. | |
|---|---|---|---|
| $C_6H_5NH_2$. | $C_6H_5NH_2.HCl$. | $H_2O$. | $C_6H_5NH_2.HCl$. |
| 3.615 | 0 | 7.276 | 3.025 |
| 3.791 | 1.529 | 7.231 | 1.989 |
| 4.144 | 5.829 | 5.816 | 1.195 |
| 4.940 | 11.44 | 5.230 | 0.340 |
| 5.995 | 16.03 | 5.006 | 0.163 |
| 10.44 | 19.35 | 4.960 | 0.080 |
| 26.80 | 21.49 | 4.942 | 0 |

Isotherm for 25°.

| $H_2O$ Rich Mixtures. Gms. per 100 Gms. Sat. Solution. | | Aniline Rich Mixtures. Gms. per 100 Gms. Sat. Solution. | |
|---|---|---|---|
| $C_6H_5NH_2$. | $C_6H_5NH_2.HCl$. | $H_2O$. | $C_6H_5NH_2.HCl$. |
| 3.681 | 0 | 14 | 8.884 |
| 4.020 | 3.02 | 10.84 | 6.062 |
| 5.380 | 11.40 | 6.949 | 1.912 |
| 7.023 | 15.83 | 6.043 | 0.828 |
| 11.86 | 19.02 | 5.568 | 0.363 |
| 31.35 | 20.15 | 5.311 | 0.089 |
| 59.95 | 15.55 | 5.299 | 0 |

Isotherm for 40°.

| | | | |
|---|---|---|---|
| 3.941 | 0 | 15.65 | 8.752 |
| 4.187 | 1.523 | 10.21 | 4.243 |
| 4.371 | 3.009 | 7.874 | 2.166 |
| 4.823 | 5.815 | 7.069 | 1.452 |
| 6.210 | 11.30 | 7.058 | 0.9669 |
| 8.779 | 15.55 | 6.225 | 0.4052 |
| 38.69 | 18 | 5.940 | 0.0960 |
| 64.20 | 12.84 | 5.930 | 0 |

Isotherm for 60°.

| | | | |
|---|---|---|---|
| 4.58 | 0 | 14.27 | 5.93 |
| 4.87 | 1.512 | 9.569 | 2.632 |
| 5.13 | 2.984 | 8.109 | 1.112 |
| 5.67 | 5.762 | 7.492 | 0.4876 |
| 7.69 | 11.14 | 7.051 | 0.2284 |
| 11.53 | 15.25 | 7.047 | 0.1138 |
| 22.80 | 16.66 | 7.030 | 0 |
| 51.10 | 14.36 | | |

Isotherm for 80°.

| | | | |
|---|---|---|---|
| 5.66 | 0 | 12.31 | 3.387 |
| 5.95 | 1.495 | 9.848 | 1.350 |
| 6.26 | 2.950 | 8.998 | 0.5857 |
| 7.11 | 5.678 | 8.524 | 0.2769 |
| 9.95 | 10.85 | 8.512 | 0.1387 |
| 31.18 | 14.85 | 8.500 | 0 |

Isotherm for 100°.

| | | | |
|---|---|---|---|
| 7.10 | 0 | 41.57 | 11.45 |
| 7.68 | 1.467 | 18.16 | 4.995 |
| 8.10 | 2.891 | 12.76 | 1.784 |
| 9.60 | 5.522 | 11.37 | 0.1836 |
| 13.60 | 10.41 | 11.90 | 0 |

Isotherm for 120°.

| | | | |
|---|---|---|---|
| 9.30 | 0 | 17.94 | 2.459 |
| 21.21 | 9.497 | 14.45 | 0 |

Isotherm for 140°.

| | | | |
|---|---|---|---|
| 13.75 | 0 | 29.52 | 4.043 |
| 38.75 | 7.384 | 21.09 | 0 |

The authors also calculated the position of tie lines for the binodal curves with the aid of distribution coefficients, which they determined at 25° and which are quoted in a subsequent table (page 420 following).

Additional data for the system aniline + HCl + $H_2O$ at 0°, 25° and at 35° are given by Thonus (1913), and for aniline + HCl by Leopold (1910).

## Solubility of Aniline in Aqueous Aniline Hydrochloride Solutions at 18°.

(Lidow — J. russ. phys. chem. Ges. 15, 420, '83; Ber. 16, 2297, '83.)

| Per cent $C_6H_5NH_2HCl$ in Solvent. | Gms. $C_6N_5NH_2$ per 100 g. Solvent | Per cent $C_6H_5NH_2.HCl$ in Solvent. | Gms. $C_6H_5NH_2$ per 100 g. Solvent. |
|---|---|---|---|
| 5 | 3·8 | 30 | 39·2 |
| 12 | 5·3 | 35 | 50·4 |

## Solubility of Aniline in Aqueous Solutions of Acetic Acid.

(Angelescu and Motzoc, 1925.)

The determinations were made by adding aniline drop by drop to water or aqueous acetic acid just to the appearance of clouding at a definite temperature. The quantities of the three constituents were determined by careful weighings.

Results at 0°.

Gms. per 100 gms. sat. sol.

| $C_6H_5NH_2$. | $CH_3COOH$. | $H_2O$. |
|---|---|---|
| 3.68 | 0.00 | 96.32 |
| 7.13 | 2.89 | 89.98 |
| 10.00 | 5.91 | 84.09 |
| 13.59 | 9.74 | 76.67 |
| 17.10 | 12.41 | 70.49 |
| 20.82 | 14.02 | 65.16 |
| 26.76 | 15.33 | 57.88 |
| 30.10 | 15.73 | 54.17 |
| 32.17 | 15.88 | 51.95 |
| 34.75 | 16.01 | 49.24 |
| 37.76 | 16.16 | 46.08 |
| 38.72 | 16.20 | 45.08 |
| 47.68 | 16.26 | 36.06 |
| 58.15 | 15.60 | 26.25 |
| 68.92 | 13.38 | 17.70 |
| 76.83 | 10.68 | 12.49 |
| 83.36 | 6 23 | 7.41 |
| 90.37 | 4.02 | 5.61 |
| 95.71 | 0.00 | 4.29 |

Results at 20°.

Gms. per 100 gms. sat. sol.

| $C_6H_5NH_2$. | $CH_3COOH$. | $H_2O$. |
|---|---|---|
| 3.59 | 0.00 | 96.41 |
| 4.14 | 0.35 | 95.51 |
| 5.30 | 1.41 | 93.29 |
| 7.58 | 3.87 | 88.55 |
| 11.05 | 8.08 | 80.87 |
| 15.73 | 12.16 | 72.11 |
| 22.26 | 14.86 | 62.88 |
| 26.56 | 15.67 | 57.72 |
| 30.80 | 16.18 | 53.02 |
| 34.03 | 16.40 | 49.57 |
| 43.91 | 16.59 | 39.50 |
| 58.64 | 16.39 | 24.97 |
| 63.76 | 15.63 | 20.61 |
| 67.90 | 14.33 | 17.77 |
| 76.68 | 10.73 | 12.59 |
| 81.43 | 8.69 | 9.88 |
| 86 58 | 5.94 | 7.48 |
| 91.18 | 3.07 | 5.75 |
| 94.84 | 0.00 | 5.16 |

In order to determine which of the above mixtures represent the upper and lower layers in contact with each other, a series of determinations of the distribution of acetic acid between water and aniline was needed. The results of these determinations at 20°, are as follows :

| Gms. $CH_3COOH$ per 100 gms. | | |
|---|---|---|
| $H_2O$ layer ($C_1$). | $C_6H_5NH_2$ layer ($C_2$). | $\frac{C_1}{C_2}$. |
| 1.68 | 0.65 | 2.58 |
| 2.15 | 0.92 | 2.33 |
| 3.05 | 1.51 | 2.02 |
| 4.65 | 2.56 | 1.82 |
| 5.22 | 3.11 | 1.68 |

| Gms. $CH_3COOH$ per 100 gms. | | |
|---|---|---|
| $H_2O$ layer ($C_1$). | $C_6H_5NH_2$ layer ($C_2$). | $\frac{C_1}{C_2}$. |
| 6.82 | 4.33 | 1.57 |
| 8.77 | 6.22 | 1.41 |
| 9.63 | 7.25 | 1.33 |
| 11.19 | 9.30 | 1.20 |

The authors next determined the temperatures at which two layers are formed in solutions containing constant concentrations of acetic acid and variable percentages of water and aniline. For this purpose mixtures of aniline and acetic acid and of water and acetic acid, containing in both cases the same weight per cent of acetic acid, were prepared. Variable mixtures of these two solutions yield in every case a ternary mixture containing a constant concentration of acetic acid. On gradually changing the temperature of such ternary mixtures, containing respectively 15.83, 16.25 and 16.56 per cent of $CH_3CO\,OH$, an upper and a lower point was found at which clouding occurs. Thus for these ranges of concentration the systems yield closed curves of solubility having an upper and a lower critical temperature of solution.

## ANILINE

### Variation of the Temperature of Solution in Ternary Mixtures Containing :

| 15.83 % $CH_3COOH$ | | | 16.25 % $CH_3CO OH$. | | | 16.56 % $CH_3CO OH$. | | |
|---|---|---|---|---|---|---|---|---|
| Gms. $C_6H_5NH_2$ per 100 gms. mixture. | Lower temp. | Upper temp. | Gms. $C_6H_5NH_2$ per 100 gms. mixture. | Lower temp. | Upper temp. | Gms. $C_6H_5NH_2$ per 100 gms. mixture. | Lower temp. | Upper temp. |
| 56.60 | + 2.0 | 35.6 | 51.88 | 10.4 | 34.9 | 47.25 | 22.7 | 29.0 |
| 55.40 | — 10.3 | 43.0 | 49.88 | 3.8 | 42.2 | 46.52 | 20 5 | 33.5 |
| 54.22 | not. det. | 47.5 | 47.89 | 0.4 | 46.4 | 45.42 | 18.8 | 36.1 |
| 52.32 | » | 52.0 | 45.46 | 0 2 | 49.8 | 44.10 | 18.0 | 38.8 |
| 51.0 | » | 54.6 | 42.71 | 1.0 | 52.8 | 42.79 | 17.7 | 40.6 |
| 49.34 | » | 57.6 | 39 91 | 3.7 | 54.5 | 41.30 | 18.1 | 42.3 |
| 47.25 | » | 60.2 | 36.95 | 7.4 | 55.5 | 39.82 | 19.4 | 43.0 |
| 45.67 | » | 62.0 | 35.43 | 9.9 | 55 5 | 38.53 | 20.5 | 43.1 |
| 43.85 | » | 63.2 | 34.61 | 11.5 | 55.3 | 37.14 | 22.7 | 43 0 |
| 41.98 | » | 64.2 | 33.94 | 12.7 | 54.7 | 35.87 | 25 2 | 42.7 |
| 40.31 | » | 65.1 | 33.38 | 13.9 | 54.2 | 35.02 | 27.6 | 41.1 |
| 38.77 | » | 65.0 | 32.76 | 15.5 | 53.7 | 34.32 | 30.3 | 39.3 |
| 37.53 | » | 65.1 | 32.15 | 17.2 | 53.0 | 33.43 | 33.6 | — |
| 36.33 | » | 65.4 | 31.49 | 19.3 | 51.8 | | | |
| 35.14 | — 8.6 | 65.3 | 30.85 | 22.0 | 49.9 | | | |
| 33.81 | — 5.3 | 65.2 | 30.27 | 25.0 | 47 9 | | | |
| 32.87 | — 2.8 | 64.9 | 29.97 | 26.8 | 46 3 | | | |
| 31.81 | + 0.2 | 64.2 | 29.66 | 29.4 | 44 3 | | | |
| 30.82 | 3.3 | 63 3 | 29.43 | 31.9 | 41.8 | | | |
| 29.51 | 8.0 | 61.4 | | | | | | |
| 28.38 | 12.8 | 58.7 | | | | | | |
| 27.74 | 16.1 | 56.4 | | | | | | |
| 27.37 | 18.2 | 55.6 | | | | | | |
| 26.85 | 21.7 | 52.7 | | | | | | |
| 26.42 | 25.3 | 50.0 | | | | | | |
| 26.06 | 29.1 | 46.6 | | | | | | |
| 25.84 | 32.6 | 43.6 | | | | | | |
| 25.73 | 35.7 | 40.0 | | | | | | |

With mixtures containing 16.75 % $CH_3COOH$ two layers were not formed but an intense opalescence between 25° and 30° was observed.

### Solubility of Aniline in Aqueous Solutions of Ethyl Alcohol, and of Mixtures of Ethyl Alcohol and Nitrobenzene.

(Rossett, M range and Vinter, 1923.)

| t° of clouding..... | 26.5. | 22.5. | 14.5. | 8.0. | 2.5. |
|---|---|---|---|---|---|
| In mixtures composed of 10 gms. $C_6H_5NH_2$ + 5 cc. of Aq. $C_2H_5OH$ of : | 57.5 % | 58.3 % | 59.3 % | 61.2 % | 62.8 % |

| t° of clouding. | In 5 cc. Aq. 59.3 % $C_2H_5OH$ + 10 cc. of a mixture of $C_6H_5NH_2 + C_6H_5NO_2$ containing : |
|---|---|
| 14.5..... | 0.0 % $C_6H_5NO_2$ |
| 16.0..... | 1.005 » |
| 20.00..... | 3.26 » |

| t° of clouding. | In 5 cc. Aq. 59.3 % $C_2H_5OH$ + 10 cc. of a mixture of $C_6H_5NH_2 + C_6H_5NO_2$ containing : |
|---|---|
| 24.5..... | 5.84 % $C_6H_5NO_2$ |
| 34 0..... | 11.54 » |
| 43.5..... | 17.22 » |

| t° of clouding. | In 5 cc. Aq. 68.2 % $C_2H_5OH$ + 10 cc. of a mixture of $C_6H_5NH_2 + C_6H_5NO_2$ containing : |
|---|---|
| 14.0... | 22.89 % $C_6H_5NO_2$ |
| 21.0... | 28.16 » |
| 29...:. | 87.43 » |

| t° of clouding. | In 5 cc. Aq. 80 % $C_2H_5OH$ + 10 cc. of a mixture of $C_6H_5NH_2 + C_6H_5NO_2$ containing : |
|---|---|
| 19... | 78.13 % $C_6H_5NO_2$ |
| 26... | 82.13 » |
| 88... | 87,43 » |

| t° of clouding. | In 5 cc. Aq. 89 % $C_2H_5OH$ + 10 cc. of a mixture of $C_6H_5NH_2 + C_6H_5NO_2$ containing : |
|---|---|
| 6.0... | 91.49 % $C_6H_5NO_2$ |
| 10.5... | 95.57 » |
| 13 5... | 98.27 » |
| 16.0... | 100.00 » |

## Solubility of Aniline in Aqueous Solutions of Lactic Acid.

(Angelesco, 1925.)

The determinations were made by adding aniline drop by drop to water or aqueous lactic acid just to the appearance of clouding at a definite temperature. The quantities of the three constituents were determined by careful weighings.

Results at 0°.

| Gms. per 100 gms. sat. solution. | | |
|---|---|---|
| $C_6H_5NH_2$. | $CH_3.CHOH.COOH$. | $H_2O$. |
| 3.68 | 0.00 | 96.32 |
| 5.43 | 1.91 | 92.66 |
| 7.86 | 4.34 | 87.80 |
| 9.78 | 6.25 | 83.97 |
| 11.89 | 8.19 | 79.92 |
| 14.57 | 10.40 | 75.03 |
| 17.00 | 11.74 | 71.26 |
| 21.23 | 12.96 | 65.81 |
| 27.94 | 13.68 | 58.38 |
| 34.07 | 13.72 | 52.21 |
| 40.56 | 13.48 | 45.96 |
| 48.19 | 12.97 | 38.84 |
| 52.07 | 12.60 | 35.33 |
| 56.27 | 12.05 | 31.68 |
| 60.97 | 11.28 | 27.75 |
| 65.82 | 10.32 | 23.86 |
| 72.60 | 8.65 | 18.75 |
| 78.84 | 6.83 | 14.33 |
| 85.14 | 4.62 | 10.24 |
| 91.95 | 1.93 | 6.12 |
| 95.71 | 0.00 | 4.29 |

Results at 20°.

| Gms. per 100 gms. sat. solution. | | |
|---|---|---|
| $C_6H_5NH_2$. | $CH_3.CHOH.COOH$. | $H_2O$. |
| 3.59 | 0.00 | 96.41 |
| 6.73 | 2.96 | 90.31 |
| 8.85 | 5.02 | 86.13 |
| 10.99 | 7.14 | 81.87 |
| 14.07 | 9.52 | 76.41 |
| 17.59 | 11.42 | 70.99 |
| 21.96 | 12.65 | 65.39 |
| 29.45 | 13.39 | 57.16 |
| 42.76 | 13.02 | 44.22 |
| 45.59 | 12.82 | 41.59 |
| 48.40 | 12.52 | 39.06 |
| 50.79 | 12.35 | 36.86 |
| 53.31 | 11.84 | 32.85 |
| 60.16 | 11.14 | 28.70 |
| 66.18 | 10.02 | 23.80 |
| 71.36 | 8.99 | 19.65 |
| 76.70 | 7.31 | 15.99 |
| 81.90 | 5.66 | 12.44 |
| 86.53 | 3.91 | 9.55 |
| 92.24 | 1.61 | 6.15 |
| 94.84 | 0.00 | 5.16 |

In order to have complete information in regard to the isotherms the author also determined the distribution of lactic acid between water and aniline at 20°.

| Gms. $CH_3CHOH.COOH$ per 100 gms. | | $\frac{C_1}{C_2}$. |
|---|---|---|
| $H_2O$ layer ($C_1$). | Aniline layer $C_2$. | |
| 2.29 | 0.32 | 7.16 |
| 4.14 | 0.64 | 6.47 |
| 7.88 | 1.85 | 4.26 |
| 9.43 | 2.80 | 3.37 |

| Gms. $CH_3CHOH.COOH$ per 100 gms. | | $\frac{C_1}{C_2}$. |
|---|---|---|
| $H_2O$ layer ($C_1$). | Aniline layer $C_2$ | |
| 11.62 | 5.18 | 2.24 |
| 12.85 | 8.20 | 1.56 |
| 13.57 | 10.01 | 1.36 |
| 13.50 | 11.70 | 1.15 |

The critical concentration at 20° is approximately 13.3 per cent $CH_2$ CHOHCOOH.

The author also determined the temperatures of solution of different percentages of aniline in three concentrations of aqueous lactic acid. The following results were read from the curves obtained by plotting the author's determinations.

### They Show the Solubility of Aniline in :

Aq. Lactic Acid of 13.27 % conc.

| | Gms. $C_6H_5NH_2$ per 100 gms. | |
|---|---|---|
| t° | lower layer. | upper layer. |
| —7... | 25.2 | 39.5 |
| —5... | 26.1 | 38 0 |
| —3... | 27.2 | 36.2 |
| —1... | 28.4 | 34.5 |
| 0... | 29.4 | 33.5 |
| +1... | 30.7 | 32.0 |
| 1.1 (crit. temp.) | 31.6 | |

Aq. Lactic Acid of 13.5 % conc.

| | Gms. $C_6H_5NH_2$ per 100 gms. | |
|---|---|---|
| t°. | lower layer. | upper layer. |
| —7... | 22.3 | 45.3 |
| 0... | 24.1 | 41.7 |
| +5... | 25.4 | 39.6 |
| 10... | 26.8 | 37.8 |
| 15... | 28.2 | 36.3 |
| 20... | 30.0 | 34.9 |
| 23 (crit. t.).. | 32.4 | |

Aq. Lactic Acid of 13.8 % conc.

| | Gms. $C_6H_5NH_2$ per 100 gms. | |
|---|---|---|
| t°. | lower layer. | upper layer. |
| — 7... | 20.9 | 49.0 |
| 0... | 22 2 | 45.1 |
| 10... | 24.2 | 42.1 |
| 20... | 26.1 | 39.9 |
| 30... | 28.0 | 38.2 |
| 40... | 30.5 | 36.0 |
| 43.4 (crit. t.). | 33.0 | |

## Solubility of Aniline in Aqueous Solutions of Glycerol and Vice Versa.

(Kolthoff, 1917.)

(The liquids were measured from burets. The determinations at 100° were made in sealed tubes. The others were made in open tubes.)

### Results for the Solubility of Aniline in Aqueous Glycerol.

| Per cent Glycerol in Aq. Mixture used. | cc. Aniline dissolved by 100 cc. of Aq. Glycerol of Conc. shown at: | | | |
|---|---|---|---|---|
| | 18°. | 25°. | 36°. | 100°. |
| 0 (= water) | 3.25 | 3.4 | 5.6 | 9.9 |
| 39 | 5.15 | 5.3 | ... | ... |
| 56 | 7.5 | 7.6 | ... | 28 (58% Glycerol) |
| 65 | 10 | ... | ... | 38 (66% " ) |
| 74.3 | 11.75 | 12.1 | ... | ... |
| 78 | 20 | 20 | 16 | ... |
| 87 | 70 | ... | ... | ... |

### Results for the Solubility of Aqueous Glycerol in Aniline.

| Per cent Glycerol in Aq. Mixture used. | cc. of Aq. Glycerol Mixture dissolved by 100 cc. Aniline at: | | | |
|---|---|---|---|---|
| | 18°. | 25°. | 36°. | 100°. |
| 0 (= water) | 4.6 | 5 | 4 | 5.3 |
| 39 | ... | 6.4 | ... | ... |
| 47 | 5.2 | ... | ... | ... |
| 56 | 7.9 | 7.7 | ... | 15 (58% Glycerol) |
| 74.3 | 13.1 | 11.7 | ... | 17 (66% " ) |
| 78 | 17.1 | 14.8 | ... | ... |

## Solubility of Aniline, Phenol Mixtures in Water.

(Schreinemaker — Z. physik. Chem. 29, 584; 30, 460, '99.)

| t°. | Mixture used = 25.4 Mols. Aniline + 74.6 Mols. Phenol. Gms. of Mixture per 100 Gms. | | t°. | Mixture used = 50 Mols. Aniline + 50 Mols. Phenol. Gms. of Mixture per 100 Gms. | |
|---|---|---|---|---|---|
| | Aq. Layer. | A + P Layer. | | Aq. Layer. | A. + P Layer. |
| 40 | 5.0 | 86.0 | 40 | 4.0 | 91.5 |
| 60 | 5.5 | 82.0 | 80 | 5.5 | 85.5 |
| 80 | 8.0 | 77.0 | 100 | 8.0 | 82.0 |
| 100 | 12.5 | 67.0 | 120 | 13.5 | 73.5 |
| 110 | 19.0 | 56.5 | 130 | 19.0 | 66.0 |
| 104 (crit. temp.) | 33 | ... | 135 | 23.5 | 58.0 |
| | | | 140 (crit. temp.) | 35 | ... |

Determinations in above table by "Synthetic Method," see Note, p. 292 Schreinemakers gives results for several other mixtures of aniline and phenol which yield curves entirely similar to those for the two mixtures here shown.

## Solubility of Mixtures of Aniline, Oils and Water. (Jansen and Schut, 1923.)

The authors determined the temperature of clouding in mixtures composed of 4 parts of aniline (containing increasing percentages of $H_2O$) and one part of oil.

### Results for Rape Oil.

| Per cent of $H_2O$ in aniline. | t° of clouding. |
|---|---|
| 0.0 | 37.6 |
| 1.16 | 44.6 |
| 2.07 | 50.4 |
| 3.11 | 57.3 |
| 4.22 | 64.5 |
| 4.87 | 69.3 |

### Results for Soya, Peanut and Corn Oil.

| Per cent of $H_2O$ in aniline. | t° of clouding with | | |
|---|---|---|---|
| | Soya Oil. | Peanut Oil. | Corn Oil. |
| 0.0 | 8.7 | 26.2 | 11.0 |
| 1.01 | 13.6 | 31.6 | 15.5 |
| 1.98 | 18.6 | 37.3 | 20.4 |
| 3.01 | 24.3 | 43.5 | 25.6 |
| 4.07 | 30.6 | 50.3 | 31.6 |
| 4.71 | 34.0 | 54.1 | 35.0 |

## Distribution of Aniline between:

(Vaubel — J. pr. Chem [2] 67, 477, '03.)

| Water and Ether. | | | | Water and Carbon Tetrachloride. | | | |
|---|---|---|---|---|---|---|---|
| Composition of Solutions. | | Gms. $C_6H_5NH_2$ in: | | Composition of Solutions. | | Gms. $C_6H_5NH_2$ in: | |
| G. $C_6H_5NH_2$ Used. | Solvent. | Aq. Layer. | Ether Layer. | G. $C_6H_5NH_2$ Used. | Solvent. | Aq. Layer. | $CCl_4$ Layer. |
| 1.2478 | 50 cc. $H_2O$ + 20 cc. Ether | 0.1671 | 1.0807 | 0.3478 | 50 cc. $H_2O$ + 20 cc. $CCl_4$ | 0.3358 | 0.012 |
| 1.2478 | 50 cc. $H_2O$ + 50 cc. Ether | 0.0835 | 1.1643 | 1.2478 | 50 cc. $H_2O$ + 50 cc. $CCl_4$ | 0.2767 | 1.971 |
| 1.2478 | 50 cc. $H_2O$ + 100 cc. Ether | 0 0594 | 1.1884 | 1.2478 | 50 cc. $H_2O$ + 100 cc. $CCl_4$ | 0.1845 | 1.063 |

## Distribution of Aniline between Water and Benzene at 25°.

(Farmer and Warth, 1904.)

| Gms. $C_6H_5NH_2$ per 100 cc. | | Ratio. |
|---|---|---|
| Water Layer. | $C_6H_6$ Layer. | |
| 0.0135 | 0.1312 | 9.7 |
| 0.0122 | 0.1282 | 10.5 |
| 0.0065 | 0.0656 | 10.1 |

Data for the distribution between water and benzene at 25° of each of the following substituted anilines; *o*, *m* and *p* nitraniline, chloraniline, bromaniline, *p* nitrosmethylaniline, and *p* nitrosodimethylaniline are given by Farmer and Warth (1904).

## Distribution of Aniline between Water and Toluene at 25°.

(Riedel, 1906.)

Note. — Mixtures of aniline and toluene were shaken with water and after separation of the two layers the Sp. Gr. of the A : T mixture (layer) was determined and also the amount of aniline in each layer.

| Solution Shaken with A : T Mixture. | Vol. per cent Aniline : Toluene in Mixtures Used. | Sp. Gr. of A : T Mixture after Separation. | Gms. $C_6H_5NH_2$ in 100 cc. of: | |
|---|---|---|---|---|
| | | | A : T Layer. | Aq. Layer. |
| $H_2O$ | 50 : 50 | 0.9257 | 41.5 | 2.14 |
| " | 25 : 75 | 0.8928 | 20.7 | 1.5 |
| " | 12.5 : 87.5 | 0.8737 | 8.62 | 0.86 |
| " | 5.5 : 94.5 | 0 8661 | 3 87 | 0 45 |
| " | 2.5 : 97.5 | 0.8627 | 1.68 | 0 21 |

The author also gives data for the distribution of aniline between toluene and aqueous solutions of $K_2SO_4$, $KBO_3$, $Ba(OH)_2$, $Sr(OH)_2$ and $Ca(OH)_2$.

## Distribution of Aniline and of Methyl Aniline between Water and Xylene at 25°. (Smith, 1921-1922.)

| Millimols. $C_6H_5NH_2$ per liter of | | $\frac{(C_2)}{(C_1)}$. |
|---|---|---|
| $H_2O$ layer ($C_1$). | Xylene layer ($C_2$). | |
| 0.150 | 0.45 | 2.9 |
| 0.203 | 0.67 | 3.3 |
| 0.279 | 1.20 | 4.3 |
| 0.378 | 2.00 | 5.3 |

| Millimols. $C_6H_5(CH_3)NH_2$ per liter of | | $\frac{(C_2)}{(C_1)}$. |
|---|---|---|
| $H_2O$ layer ($C_1$). | Xylene layer ($C_2$). | |
| 0.125 | 1.31 | 10.5 |
| 0.185 | 2.10 | 10.9 |
| 0.300 | 3.40 | 11.3 |

## Distribution of Aniline Between Aqueous Sodium Oleate Solutions and Ethyl Acetate at 25°.

(Smith, 1932a.)

| Initial Conc. of Aq. Na Oleate in Percent | Gms. $C_6H_5NH_2$ per 100 gms. Aqueous layer(1) | Gms. $C_6H_5NH_2$ per 100 gms. Acetate layer(2) | $\frac{2}{1}$ | Initial Conc. of Aq. Na Oleate in Percent | Gms. $C_6H_5NH_2$ per 100 gms. Aqueous layer(1) | Gms. $C_6H_5NH_2$ per 100 gms. Acetate layer(2) | $\frac{2}{1}$ |
|---|---|---|---|---|---|---|---|
| 0.0 | 0.00182 | 0.0561 | 30.7 | 10.83* | 0.0610 | 0.422 | 6.9 |
| 0.0 | 0.0146 | 0.442 | 30.2 | 10.83* | 0.0648 | 0.439 | 6.8 |
| 0.0* | 0.0146 | 0.481 | 33.0 | 10.83 | 0.0728 | 0.517 | 7.1 |
| 0.0 | 0.0182 | 0.550 | 30.3 | 10.83 | 0.0752 | 0.528 | 7.0 |
| 0.0 | 0.157 | 4.62 | 29.5 | 10.83 | 0.534 | 3.82 | 7.15 |
| 1.5 | 0.0242 | 0.542 | 22.4 | 10.83 | 2.239 | 16.90 | 7.55 |
| 2.95 | 0.0320 | 0.539 | 16.8 | 13.2 | 0.0844 | 0.501 | 5.93 |
| 2.95* | 0.0256 | 0.399 | 15.6 | 17.55 | 0.1106 | 0.509 | 4.61 |
| 4.37 | 0.0360 | 0.436 | 12.1 | 21.5 | 0.1507 | 0.620 | 4.11 |
| 5.73 | 0.0303 | 0.316 | 10.5 | 21.5 | 0.1584 | 0.649 | 4.10 |
| 8.36 | 0.0502 | 0.396 | 7.9 | 26.7 | 0.1229 | 0.469 | 3.82 |

* In these cases NaCl was present to the extent of 0.5 normal.

## Solubility of Aniline in Sulphur.

(Alexejew — Ann. Physik. Chem. 28, 305, '86)

| t°. | Gms. $C_6H_5NH_2$ per 100 g. S. Layer. | Anilin Layer. | t° | Gms $C_6H_5NH_2$ per 100 g. S. Layer. | Anilin Layer. |
|---|---|---|---|---|---|
| 100 | 4 | 75 | 130 | 15 | 58 |
| 110 | 6 | 70 | 135 | 17 5 | 47 |
| 120 | 10 | 64 | 138 (crit. temp.) | 23 | .. |

## Reciprocal Solubility of Aniline and Hexane.

(Keyes and Hildebrand, 1917.)

| t° of Complete Miscibility. | Gms. Hexane per 100 Gms. Mixture. | t° of Complete Miscibility. | Gms. Hexane per 100 Gms. Mixture. |
|---|---|---|---|
| 26.1 | 9.6 | 59.2 | 35.9 |
| 43.9 | 14.8 | 59.4 | 41.6 |
| 45.9 | 16.3 | 59.6 | 48 |
| 49.9 | 20 | 57.9 | 62.9 |
| 51.4 | 21 | 53.9 | 73.1 |
| 56 | 27.2 | 47.2 | 80.6 |
| 58.2 | 31 | 35.6 | 88.1 |
| 58.2 | 34.6 | 16.5 | 93.8 |

## Reciprocal Solubility of Aniline and Phenol, Determined by the Freezing-Point Method.

(Schreinemakers, 1899.)

| t° of Melting. | Mols. $C_6H_5NH_2$ per 100 Mols. Mixture. | Solid Phase. | t° of Melting. | Mols. $C_6H_5NH_2$ per 100 Mols. Mixture. | Solid Phase. |
|---|---|---|---|---|---|
| − 6.1 | 100 | $C_6H_5NH_2$ | 30.4 m. pt. | 50 | 1.1 |
| − 8.9 | 96 | " | 28.6 | 40 | " |
| −11.7 Eutec. | 92.3 | $C_6H_5NH_2$+1.1 | 22.3 | 30 | " |
| − 6.5 | 90 | 1.1 | 14.8 Eutec. | 21.2 | 1.1+$C_6H_5OH$ |
| +10.1 | 80 | " | 18.4 | 20 | $C_6H_5OH$ |
| 22 | 70 | " | 31.4 | 10 | " |
| 28.5 | 60 | " | 37.3 | 4 | " |

1.1 = $C_6H_5NH_2.C_6H_5OH$.

Data for the solubility of aniline in cyclohexane at pressures up to 300 atmospheres are given by Kohnstamm and Timmermans (1913).

MUTUAL SOLUBILITY OF ANILINE AND CYCLOHEXANE. (Buchner and Kleyn, 1924.)

| Saturation temp. | 18°.3. | 29°.8. | 31°.2. | 31°.3. | 31°.3. | 30°.3. | 29°.4. | 24°.6. | 23°.6. |
|---|---|---|---|---|---|---|---|---|---|
| Gms. $C_6H_5NH_2$ per 100 gms. sat. sol... | 11.5 | 19.3 | 26.8 | 40.0 | 57.2 | 64.9 | 68.0 | 75.0 | 76.0 |

Later very careful determinations of this system are given by Schlegel, 1934.

CRITICAL SOLUTION TEMPERATURES OF ANILINE, IN VARIOUS SOLVENTS. (Thiry, 1925.)

| Solvent. | Constants of the solvent. f. pt. | b. pt. | $d_{\frac{15}{4}}$. | Mol. wt. | Solubility results. Critical solution temp. | Per cent conc. $C_6H_5NH_2$ at C. S. t. |
|---|---|---|---|---|---|---|
| Cyclopentane | - 94.8 | 49.37 (49.5) | 0.7505 (0.750) | 70 08 | 16.8 (18°) | 37.5 |
| Methyl cyclopentane | -141.0 | 71.9 (72.0) | 0.7528 (0.7533) | 84.1 | 35.2 (35) | 30.0 |
| Ethyl » | -137.9 | 103.0 | 0.7710 | 98.11 | 39.8 | 35.0 |
| Propyl » | -120.3 | 131.4 | 0.7813 | 112.13 | 45.5 | 40.0 |
| Butyl » | -108.2 | 156.8 | 0.7887 | 126.15 | 51.1 | 42.5 |
| Cyclo hexane | + 6.55 | 80.77 (80.8) | 0.7830 ($d_4^0$ 0.7967) | 84.036 | 30.8 (31.0) | 40.0 |
| Methyl cyclohexane | -147.5 | 100.5 (100.4) | 0.7693 ($d_4^0$ 0.798) | 98.112 | 41.0 (41.0) | 40.0 |
| Hexane | - 94.65 | 69.0 (69.0) | 0.6780 (0.6638) | 86 112 | 69.2 (69.0) | 41.0 |
| Methyl 3 pentane | — | 63.2 | 0.6687 | - | 69.6 | 41.5 |
| Isohexane | -137.1 | 60.18 (61.7-62.4) | 0.6580 (0.658) | - | 74.9 (73.8) | 37.5 |
| Trimethylethylmethane | - 98.2 | 19.70 | 0.6538 | - | 80.65 | 40.0 |

The results given in parentheses in the above table are those of Chavanne and Simon, 1919 and 1920. These authors also give for mixtures containing aniline the following additional critical solution temperatures. Isopentane (b. p. 27°-29°; $d_{\frac{15}{4}}$ = 0.6394) 77°; Pentane (b. p. 35°.8-36°.3; $d_{\frac{15}{4}}$ 0.6454) 72°; Isoheptane (b. p. 90-91°; $d_{\frac{15}{4}}$ = 0.6842) 72°.8; Heptane (b. pt. 98°-98°.3; $d_{\frac{15}{4}}$ = 0.6879) 70°; Isooctane (b. p. 116°) 74°; Octane (b. p. 125.8°; $d_{\frac{15}{4}}$ = 0.7063) 72°; Dimethylcyclopentane (b. p. 91°-94°) 45°; Dimethylcyclohexane (b. pt. 121.2°-121.8°; $d_{\frac{15}{4}}$ = 0.775) 49°.

Van Rysselberge, gives 42° as the C. S. T. of Aniline + Dimethyl 1.2 Cyclopentane.

CRITICAL SOLUTION TEMPERATURES OF MIXTURES OF ANILINE AND OTHER COMPOUNDS.

| Mixture of Aniline and: | C.S.T. | Mixture of Aniline and: | C.S.T. |
|---|---|---|---|
| Cyclohexane | 30.2(4) | Hexane | 65.9(8) |
| " | 31.0(3)(7) | " | 67.3(4) |
| n Decane | 77.5(2) | " | 69.0(2) |
| " | 77.6(3) | " | 70.0(7) |
| Di iso butyl | 78.3(5) | Methyl cyclo hexane | 40 (4) |
| 2.5 Dimethyl hexane | 77.2(1) | " " " | 41 (6)(7) |
| 2.2 Dimethyl pentane | 68.1(1) | " cyclo pentane | 34.7(3) |
| 2.3 " " | 78.8(1) | 2, Methyl hexane | 74.1(1) |
| 2.4 " " | 71.0(1) | 3, " " | 70.5(1) |
| 3.3 " " | 83.7(2) | n Nonane | 74.4(2) |
| n Dodecane | 66.3(1) | n Octane | 71.8(2) |
| 3 Ethyl pentane | 67.3(4) | n Pentane | 71.4(2) |
| n Heptane | 69.9(2) | 2,2,3 Trimethyl butane | 72.4(1) |
| " | 70.0(1)(3) | n Undecane | 80.6(2) |

(1) Edgar, Calingaert and Marken, 1929; (2) Shepard, Henne and Midgley, Jr., 1931; (3) Bruun, Hicks-Bruun, 1931, 1932; (4) Schaarschmidt, Hofmeier and Leist, 1930; (5) Timmermans and Hennant-Roland, 1932; (6) Hicks-Bruun and Bruun, 1932; (7) Dessart, 1926; (8) Drucker, 1923.

RECIPROCAL SOLUBILITY OF ANILINE AND HYDROCARBONS. (Tizard and Marshall, 1921.)

The authors desired a method for the determination of aromatic hydrocarbons in certain mixtures. For this purpose they made a long series of experiments showing the effect of the addition of various aromatic hydrocarbons, upon the temperature of clouding of mixtures of equal volumes of aniline and a sample of « petrol », free of aromatic hydrocarbons. The results are presented, for the most part, in the form of curves.

THE FREEZING-POINTS OF ANILINE CONTAINING SMALL AMOUNTS OF IMPURITIES. (Sanderson and Jones, 1920.)

Mixtures of pure dry aniline and the several compounds, each carefully purified and dried, were prepared and their freezing-points determined. The table shows the percentage by weight of aniline in the mixture and the corresponding freezing-point.

| Wt. per cent of Aniline. | Freezing-point of the dry binary mixture of aniline with | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Benzene. | Phenyl hydroxyl amine. | Nitroso benzene. | *p* Amino phenol. | Nitro benzene. | *o* Toluidine. | *p* Toluidine. | *m* Phenylene diamine. | Xylidine. |
| 100 | —6.00 | —6.00 | —6.00 | —6.00 | —6.00 | — 6.00 | —6.00 | —6.00 | —6.00 |
| 99 | —7.18 | —6.47 | —6.58 | —6.58 | —6.53 | — 6.60 | —6.65 | —6.60 | —7.00 |
| 98 | —8.00 | —6.94 | —7.16 | —7.16 | —7.03 | — 7.18 | —7.25 | —7.18 | —7.75 |
| 97 | —8.70 | —7.41 | —7.74 | —7.74 | —7.50 | — 7.75 | —7.85 | —7.75 | —9.00 |
| 96 | —9.30 | | | | —7.97 | — 8.33 | —8.45 | – | – |
| 95 | – | – | | – | —8.43 | — 8.95 | —9.05 | – | |
| 94 | – | – | – | | —8.85 | — 9.53 | —9.63 | – | – |
| 93 | – | – | – | – | —9.27 | —10.11 | – | – | – |

Freezing-point data are given for mixtures of Aniline and:

Acetanilide(15)
Acetic acid(8)(12)(14)
Acetone(16)(17)
Amino phenol(3)
Allyl mustard oil(21)(22)
Allyl phenyl thio urea (15)
Benzene(2)(9)
Benzoic acid(8)(23)
Carbon tetra chloride(16)(17)
Chloroform(25)
Chloro phenol(26)
Chloro nitro benzenes(27)(28)
Cresols(29)(30)
Crotonic acid nitrile(10)
Cyclohexane(1)(9)
Dibrom ethane(17)
Diethyl aniline(19)(20)
Dinitro benzenes(28)(31)
Dinitro phenol(29)
Dinitro toluenes(6)(29)
Ethyl acetate(18)
Ethyl aniline(20)
Ethylene bromide(16)(17)
Ethyl ether(17)
Guaiacol(13)
Hydroquinone(28)
Iso pentane(32)
Mercuric acetate(11)
Naphthols(5)
Nitro benzene(9)(31)
Nitro phenols(28)
Nitroso benzene(31)
Nitroso dimethyl aniline(31)
Nitro toluene(31)
Phenol(1)
Pyrocatechol(29)
Pyrogallol(7)
Resorcinol(28)
Toluene(16)(17)
Toluidine(9)
Trinitro benzene(31)
Trinitro toluene(29)
Triphenyl methane(4)
Vinyl acetic nitrile (10)

(1) Deffet, 1938; (2) Kremann and Borjanovics, 1916; (3) Kremann and Hohl, 1920; (4) Kremann, Odelga and Zawodsky, 1921; (5) Kremann, Lupfer and Zawodsky, 1920; Kremann, Hönigsberg and Mauermann, 1923; (7) Kremann and Zechner, 1918; (8) Kremann, Weber and Zechner, 1925; (9) Linard, 1925; (10) Lafortune, 1923; (11) Mameli and Cocconi, 1922; (12) O'Connor, 1921; (13) Puschin and Vaic, 1926; (14) Puschin and Rikovski, 1932; (15) Schischokin, 1930; (16) Timmermans, 1928; (17) Timmermans, 1930; (18) Wroczynski and Guye, 1910; (19) Yamamura, 1926; (20) Yaginuma and Hayakawa, 1932; (21) Kurnakof and Kviot, 1913; (22) Kurnakov and Solover, 1916; (23) Baskov, 1913; (25) Tsakalatos and Guye, 1910; (26) Bramley, 1916; (27) Kremann, 1907; (28) Kremann and Rodinis, 1906; (29) Kremann, 1906; (30) Philip, 1903; (31) Kremann, 1904; (32) Campetti and del Grosso, 1913.

**ANILINE HYDROCHLORIDE** $C_6H_5NH_2.HCl$.

100 cc. $H_2O$ dissolve 17.8 gms. of the salt at 15°. (Niementowski and Roszkowski, 1897.)
100 gms. $H_2O$ dissolve 107.1 gms. of the salt at 25°. (Peddle and Turner, 1913.)
100 gms. sat. solution in water contain 52.1 gms. $C_6H_5NH_2.HCl$ at 25°.
100 gms. sat. solution in aniline contain 8.89 gms. $C_6H_5NH_2.HCl$ at 25°.
(Sidgwick, Pickford and Wilsden, 1911.)

DISTRIBUTION OF ANILINE HYDROCHLORIDE BETWEEN WATER AND ANILINE AT 25°
(Sidgwick, Pickford and Wilsden, 1911.)

| $C_{aq.}$ | $C_{an.}$ | $C_{aq.}/C_{an.}$ | $C_{aq.}$ | $C_{an}$ | $C_{aq.}/C_{an.}$ | $C_{aq.}$ | $C_{an.}$ | $C_{aq.}/C_{an.}$ |
|---|---|---|---|---|---|---|---|---|
| 0.11 | 0.006 | 19.30 | 0.6 | 0.219 | 2.74 | I | 0.804 | I.24 |
| 0.2 | 0 020 | I0 | 0.7 | 0.327 | 2.I4 | I.I | I.005 | I |
| 0.3 | 0.043 | 6.98 | 0.8 | 0.47I | I.70 | I.2 | I.228 | 0.98 |
| 0.4 | 0.086 | 4.65 | 0.9 | 0.63I | I.43 | I.3 | I.4I2 | 0.92 |
| 0.5 | 0.I46 | 3.42 | | | | | | |

$C_{aq.}$ = gms. salt per 100 gms. aq. layer. $C_{an.}$ = gms. salt per 100 gms. aniline layer.

Freezing-point data for mixtures of $C_6H_5NH_2.HCl + AsBr_3$ are given by Puschin and Löwy, 1926.

**ANILINE OXALATE** $C_6H_5NH_2.(COOH)_2$.

SOLUBILITY OF ANILINE OXALATE AND OF ETHYL ANILINE OXALATE AND OF DIMETHYL ANILINE OXALATE, EACH SEPARATELY IN WATER AND IN AQUEOUS ALCOHOL.
(Desvergnes, 1930.)

| Solvent | t° | Gms. per 100 gms. solvent: Aniline Oxalate | Ethyl aniline Oxalate | Dimethyl aniline Oxalate |
|---|---|---|---|---|
| Water | 0 | 0.748 | 4.439 | 2.706 |
| " | 16.5 | 1.542 | 6.882 | 14.214 |
| " | 50.0 | 3.01 | — | 49.23 |
| Aq. 50 wt. % $C_2H_5OH$ | 0 | 0.430 | 7.736 | 7.317 |
| " " " | 20.5 | 0.748 | 16.716 | 14.111 |
| " " " | 50.0 | 2.93 | 103.47 | 59.39 |
| Aq. 95 wt. % $C_2H_5OH$ | 0 | 0.201 | 2.591 | 1.738 |
| " " | 18.5 | 0.513 | 3.959 | 2.131 |

**ANILINE SULFATE** $C_6H_5NH_2.H_2SO_4$.

100 cc. $H_2O$ dissolve 6.6 gms. $C_6H_5NH_2.H_2SO_4$ at 15°. (Niementowski and Roszkowski, 1897.)

**ANILINE HELIANTHATE** $C_6H_5NH_2.C_{14}H_{15}N_3SO_3$; also Methyl and Dimethyl Aniline Helianthates.

1000 cc. $H_2O$ dissolve 0.26 gm. Aniline Helianthate at 20°-25° (Stark and Dehn, 1918.)
1000 cc. " 0.54 gm. Methyl " " "
1000 cc " 0.70 gm. Dimethyl " " "

**ANILINE CHLOROSTANNATE** $(C_6H_5NH_2)_2.H_2SnCl_6$.

00 cc. $H_2O$ dissolve about 28.0 gms. aniline chlorostannate at 16° (Druce, 1918.

Methyl **PYRIDINES** (Picolines) $CH_3C_5H_4N$.

Data for the reciprocal solubility of 3 methyl pyridine (= β picoline) and water, 2.6 dimethyl pyridine (= 2.6 lutidine) and water, methyl pyridine (= γ picoline) zinc chloride and water, methyl pyridine zinc chloride and each of the following alcohols; methyl, ethyl, propyl, isobutyl, isoamyl, cetyl and methyl hexylcarbinol, determined by the synthetic method (see Note, p 292), are given by Flaschner (1909). See also p. 616, for 2.4.6 trimethyl pyridine (collidine) and water.

1000 cc. $H_2O$ dissolve 65.3 gms. α Picoline Helianthate at 20-25° (Stark and Dehn, 1918.

## Amino PHENOLS *o*, *m* and *p* $C_6H_4.OH.NH_2$.

### Solubility of Each Separately in Water and in Benzene.

(Sidgwick and Callow, 1924.)

The determinations were made by the sealed tube method. In the case of meta amino phenol it was difficult to avoid supersaturation. By proper care the two-liquid curve (L) lying some 60° below the stable solid curve (S) and even the meta stable ice curve in dilute solution, could be determined.

### Results for the Solubility in Water :

| Ortho Amino Phenol. | | Meta Amino Phenol. | | | Para Amino Phenol | |
|---|---|---|---|---|---|---|
| t°. | Wt. per cent $C_6H_4.OH.NH_2$ (*o*). | t° (S). | t° (L). | Wt. per cent $C_6H_4.OH.NH_2$ (*m*). | t°. | Wt. per cent $C_6H_4.OH.NH_2$ (*p*) |
| 0.0.... | 1.7 | 20.0..... | – | 2.76 | 0.0.... | 1.1 |
| 80.8.... | 3.02 | 32.6..... | – | 3.69 | 59..... | 3.01 |
| 88.0.... | 4.04 | 47.9..... | | 8.0 | 77..... | 6.44 |
| 100.2.... | 7.10 | 53.0..... | – | 10.69 | 86.7.... | 10 09 |
| 107.1.... | 9.98 | 60.4..... | —7 L* | 18.13 | 96.6.... | 19.53 |
| 116.7.... | 17.93 | — 4.2 L* Ice | – | 18.13 | 102.0.... | 33.42 |
| 120.9.... | 25.08 | – ..... | —4.6 L* | 20.16 | 103.7.... | 40.34 |
| 123.8.... | 31.96 | – ..... | —2.0 L* | 25.47 | 106.5.... | 50.79 |
| 126.2.... | 40.03 | 66.4..... | +0.3 L* | 30.62 | 110.1.... | 59.95 |
| 128.6.... | 50.17 | 68.9..... | +1.3 L* | 40.18 | 116.5.... | 69.95 |
| 131.7.... | 59.73 | 70.2..... | +1.9 L* | 46.93 | 128.0.... | 79.93 |
| 135.8.... | 69.61 | 71.5..... | +1.7 L* | 52.67 | 145.8.... | 89.48 |
| 143.0.... | 80.46 | 73.2..... | +0.2 L* | 59.27 | 186.0.... | 100.0 |
| 155.6.... | 90.48 | 77.2..... | – | 68.87 | | |
| 177.0.... | 100.0 | 85.2..... | – | 80.89 | | |
| | | 96.0..... | – | 88.84 | | |
| | | 122.1..... | – | 100.00 | | |
| | | —4.0 tr. pt. | | 21.5 | | |
| | | +1.9 crit. sol. pt. | – | – | | |

L indicates that a second liquid phase separates.
* Indicates metastable points.

### Results for the Solubility in Benzene :

| Ortho Amino Phenol. | | Meta Amino Phenol. | | Para Amino Phenol. | |
|---|---|---|---|---|---|
| t°. | Wt. per cent $C_6H_4.OH.NH_2$ (*o*). | t°. | Wt. per cent $C_6H_4.OH.NH_2$ (*m*). | t°. | Wt. per cent $C_6H_4.OH.NH_2$ (*p*). |
| 114.9..... | 3.87 | 96.5..... | 4.87 | 103..... | 3.16 |
| 132.2..... | 9.02 | 105.9 (100.8 L*). | 10.4 | 124..... | 7.56 |
| 141.8..... | 16.1 | 114.3 L..... | 20.3 | 130..... | 11.6 |
| 146.8..... | 23.2 | 121.2 L..... | 31.3 | 135..... | 20.4 |
| 149.7..... | 29.3 | 122.1 L..... | 37.7 | 138.5..... | 30.4 |
| 151.5..... | 34.1 | 122.3 L (crit. t.). | 40.0 | 143..... | 40.1 |
| 153.6..... | 41.3 | 122.1 L..... | 46.1 | 145..... | 51.0 |
| 155.7..... | 49.3 | 121.9 L..... | 50.9 | 149..... | 60.9 |
| 158.4..... | 59.7 | 119.3 L..... | 59.0 | 154..... | 69.2 |
| 161.5..... | 69.8 | 111.2 L..... | 68.9 | 186..... | 100.0 |
| 165.2..... | 80.4 | 110 8 (105.8 L*). | 72.5 | | |
| 168.2..... | 87.6 | 111.4 ( 96.9 L*). | 76.4 | | |
| 177.0..... | 100.0 | 112.6..... | 82.6 | | |
| | | 116.4..... | 91.8 | | |
| | | 110.6 (tr. pt.)... | 16.5 | | |
| | | 110.6 (tr. pt.)... | 69.4 | | |

## AMINO PHENOLS

Freezing-point data are given for mixtures of o, m and p Amino phenols by Hrynakowski and Szmyt, 1936. Results are given for mixtures of amino phenols and each of the following compounds.

Aniline (Kremann and Hohl, 1920.)
Anthracene (Bernoulli and Lotta, 1933.)
Antipyrine (Pfeiffer and Seydel, 1928b.)
Cineole (Bellucci and Grassi, 1913.)
Dinitro benzenes (Kremann, Lupfer and Zawodsky, 1920.)
Hydroquinone (Kremann and Lupfer, 1920.)
Naphthalene (Bernoulli and Lotta, 1933.)
Naphthols (Kremann, Lupfer and Zawodsky, 1920.)
Naphthylamines (Kremann and Hohl, 1920.)
Nitro phenols (Kremann, Lupfer and Zawodsky, 1920.)
Phenanthrene (Bernoulli and Lotta, 1933.)
Phenol (Kremann, Lupfer and Zawodsky, 1920.)
Phenylene diamine (Kremann and Hohl, 1920.)
Pyramidon (Pfeiffer and Seydel, 1928b.)
Pyrocatechol (Kremann, Lupfer and Zawodsky, 1920.)
Pyrogallol ( " " " "
Resorcinol " " " "
Sarcosine anhydride (Pfeiffer and Seydel, 1928.)
Toluidine (Kremann and Hohl, 1920.)

## ANILINE SULFONIC ACIDS, *o* and *m* $C_6H_4(NH_2).SO_3H$.

Solubility of Each in Water. (Philip and Colborne, 1924.)

Results for Aniline Ortho Sulfonic Acid.

| t°. | Gms. *o* $C_6H_4(NH_2)SO_3H$ per 100 gms. sat. sol. | Solid Phase. |
|---|---|---|
| 0.0.... | 0.794 | *o* $C_6H_4(NH_2)SO_3H.H_2O$ |
| 8.25... | 1.130 | » |
| 12.3.... | 1.305 | » |
| 15.55... | 1.465 | *o* $C_6H_4(NH_2)SO_3H$ |
| 16.75... | 1.52 | » |
| 25.0.... | 1.93 | » |
| 41.3.... | 3.01 | » |
| 55 0.... | 4.29 | » |
| 70.0.... | 6.36 | » |
| 85.0.... | 8.98 | » |

Results for Aniline Meta Sulfonic Acid (Metanilic Acid).

| t°. | Gms. *m* $C_6H_4(NH_2)SO_3H$ per 100 gms. sat. sol. | Solid Phase. |
|---|---|---|
| 0.0.... | 0.790 | *m* $C_6H_4(NH_2)_2SO_3H$ |
| 7.75... | 1.022 | » |
| 16.75... | 1.32 | » |
| 24.95... | 1.635 | » |
| 40.0.... | 2.395 | » |
| 55.0.... | 3.42 | » |
| 70.0.... | 4.70 | » |
| 85.0.... | 6.50 | » |
| 0.0.... | 1.07 | $2C_6H_4(NH_2)SO_3H.3H_2O$ |
| 8.35... | 1.61 | » (unstable) |
| 15.55... | 2.64 | » |
| 16.8.... | 2.37 | » |

Considerable difficulty was experienced in preventing supersaturation of the anhydrous meta aniline sulfonic acid.

Solubility of Amino Benzene Sulfonic Acids in Water.
(Vaubel, 1895.)

| Acid | Formula | t° | Gms. acid per 100 gms. sat. sol. |
|---|---|---|---|
| Ortho Aniline Sulfonic acid | o $NH_2C_6H_4SO_3H$ | 7 | 1.06 |
| Meta " " " | m " | 7 | 1.276 |
| Para " " " | p " | 6 | 0.592 |

## SULFANILIC ACID *p* $NH_2.C_6H_4SO_3H.H_2O$.

### Solubility in Water.

(Philip, 1913; results for 60° and over by Dolinski, 1905.)

| *t*°. | Gms. $NH_2.C_6H_4.SO_3H$ per 100 Gms. Sat. Sol. | Solid Phase. | *t*°. | Gms. $NH_2.C_6H_4.SO_3H$ per 100 Gms. Sat. Sol. | Solid Phase. |
|---|---|---|---|---|---|
| 0 | 0.444 | $NH_2.C_6H_4.SO_3H.2H_2O$ | 44 | 2.44 | $NH_2.C_6H_4.SO_3H.H_2O$ |
| 7.2 | 0.622 | " | 44 | 2.36 | $NH_2.C_6H_4.SO_3H$ |
| 13.3 | 0.841 | " | 47.5 | 2.52 | " |
| 18.9 | 1.093 | " | 54.5 | 2.85 | " |
| 18.9 | 1.137 | $NH_2.C_6H_4.SO_3H.H_2O$ | 60 | 3.01 | " |
| 25.1 | 1.384 | " | 70 | 3.65 | " |
| 31.1 | 1.662 | " | 80 | 4.32 | " |
| 37.2 | 2.004 | " | 100 | 6.26 | " |

### Solubility of Sulfanilic Acid in Water. (Philip and Colborne, 1924.)

| *t*°. | Gms. $NH_2.C_6H_4SO_3H$ per 100 gms. sat. sol. | Solid Phase. |
|---|---|---|
| 69.9 | 3.74 | $NH_2.C_6H_4SO_3.H$ |
| 85.0 | 4.74 | » |

Data for the solubility of trimethyl sulfanilic acid in water and in aqueous solutions of acetic and hydrochloric acids are given by Katayama and Yamada, 1920.

### Solubility of p Amino Benzene Sulfonic Acid in Aqueous Solutions of Barium Nitrate at 20°.

(Yajnik, Jain and Nath, 1925.)

The results are given only in the form of a curve from which the following approximate values have been taken.

| Gm. Mol. $Ba(NO_3)_2$ per liter aq. solvent | Gms. $NH_2C_6H_4SO_3H$ per 100 gms. solvent | Gm. Mol. $Ba(NO_3)_2$ per liter aq. solvent | Gms. $NH_2C_6H_4SO_3H$ per 100 gms. solvent |
|---|---|---|---|
| 0.0000 | 1.00 | 0.0008 | 1.40 |
| 0.00005 | 1.08 | 0.0016 | 1.51 |
| 0.0001 | 1.16 | 0.0024 | 1.56 |
| 0.0004 | 1.32 | 0.0032 | 1.59 |

The authors' results for the solubility in water are 1.0 gm. at 20°, 1.45 gm. at 30° and 1.95 gm. at 40°,

Data showing the effect of increasing amounts of several gum arabic sols. upon the solubility of Sulfanilic acid in Water are given by Brintzinger and Beir, 1934.

100 gms. sat. solution of Sulfanilic acid in liquid ammonia contain 28, gms. $NH_2.C_6H_4SO_3H(?.H_2O)$ at (?)t°. (DeCarli, 1927.)

**PHENYL HYDRAZINE** $C_6H_5NH.NH_2$.

RECIPROCAL SOLUBILITY OF PHENYLHYDRAZINE AND WATER, DETERMINED BY THE FREEZING-POINT METHOD. (Blanksma, 1910.)

| t°. | Gms. $C_6H_5NH.NH_2$ per 100 Gms. Sat. Sol. | Solid Phase. | t°. | Gms. $C_6H_5NH.NH_2$ per 100 Gms. Sat. Sol. | Solid Phase. |
|---|---|---|---|---|---|
| 0 | 0 | Ice | 19.8 | 60.1 | $C_6H_5NH.NH_2.\frac{1}{2}H_2O$ |
| − 0.3 | 2.2 | " | 20.4 | 64.2 | " |
| − 0.6 | 3.9 | " | 21.8 | 75 | " |
| − 0.7 | 4.6 | " $+C_6H_5NH.NH_2.\frac{1}{2}H_2O$ | 23 | 79.2 | " |
| + 1 | 4.7 | $C_6H_5NH.NH_2.\frac{1}{2}H_2O$ | 24.2 | 83.7 | " |
| 7 | 6 | " | 26.1 | 91 | " |
| 11.6 | 7 | " | 26.2 | 92.3. | " |
| 15 | 8 | " | 25.7 | 93.7 | " |
| 16.8 | 9.6 | " | 23.2 | 97.2 | " |
| 19.6 | 10.9 | " | 17 | 98.8 | " |
| | | | 16.6 | 99 | " $+C_6H_5NH.NH_2$ |
| | | | 19.6 m. pt. | 100 | $C_6H_5NH.NH_2$ |

Between the concentrations 10.9 and 60.1, two liquid layers are formed.

The temperatures of separation into two liquid layers of mixtures containing from 10.9 to 60 per cent $C_6H_5NH.NH_2$, are:

| t° of Separation. | Gms. $C_6H_5NH.NH_2$ per 100 Gms. Mixture. | t° of Separation. | Gms. $C_6H_5NH.NH_2$ per 100 Gms. Mixture. | t° of Separation. | Gms. $C_6H_5NH.NH_2$ per 100 Gms. Mixture. |
|---|---|---|---|---|---|
| 19.8 | 11.6 | 54.6 | 29.7 | 50.6 | 48.9 |
| 34 | 13.8 | 55.1 | 31.4 | 50 | 51.2 |
| 45 | 16.5 | 55.2 crit. t. | 33.6 | 46 | 53.5 |
| 49.4 | 18.7 | 55.2 | 36.9 | 44.2 | 54.7 |
| 52.4 | 21.9 | 55 | 39.3 | 39.6 | 56.7 |
| 54 | 25.2 | 54 | 41.7 | 24 | 59.5 |
| 54.4 | 28.3 | 52.6 | 46 | 19.8 | 60.1 |

Additional data for concentrations of $C_6H_5NH.NH_2$ above 60 per cent, are given by Oddo (1913).

Freezing-point data are given for mixtures of Phenyl hydrazine and:
Acetic Acid (Trifonow and Tscherbow, 1929; Puschin and Rikovsky, 1932a.)
Guaiacol (Puschin and Pinter, 1929; Puschin and Rikovsky, 1937.)
Phenol (Cuisa and Bernardi, 1910.)

**PHENYLENE DIAMINES** *o*, *m*, and *p*. $C_6H_4(NH_2)_2$.

SOLUBILITY IN WATER AT 20°. (Vaubel, 1895.)

100 cc. sat. solution contain 23.8 gms. *m* $C_6H_4(NH_2)_2$, $d_{20}$ of sat. sol. = 1.0317.
100 cc. sat. solution contain 3.7 gms. *p* $C_6H_4(NH_2)_2$, $d_{20}$ of sat. sol. = 1.0038.

RATIO OF DISTRIBUTION BETWEEN WATER AND BENZENE AT 25°.
(Farmer and Warth, 1904.)

Results for *o* Phenylene Diamine.

| Gms. *o* $C_6H_4(NH_2)_2$ per: | | Ratio $\frac{\text{conc. } C_6H_6}{\text{conc. } H_2O}$. |
|---|---|---|
| 50 cc. $C_6H_6$. | 1000 cc. $H_2O$. | |
| 0.0273 | 0.9818 | 0.556 |
| 0.2040 | 7.5470 | 0.541 |

Results for *m* Phenylene Diamine.

| Gms. *m* $C_6H_4(NH_2)_2$ per: | | Ratio $\frac{\text{conc. } C_6H_6}{\text{conc. } H_2O}$. |
|---|---|---|
| 50 cc. $C_6H_6$. | 1000 cc. $H_2O$. | |
| 0.0828 | 9.088 | 0.182 |
| 0.0463 | 5.260 | 0.176 |

## PHENYLENE DIAMINES *o*, *m* and *p* $C_6H_4(NH_2)_2$.

### Solubility of Each Separately in Water. (Sidgwick and Neill, 1923.)

The determinations were made by the synthetic method.

*m* phenylene diamine was found to be dimorphic. The two forms are enantiotropic with a transition point at 36°. The α form (stable above 36°) consists of brown needles, the β form (stable below 36°) of mauve plates

Results for the Ortho compound.

| t° | Gms. $C_6H_4(NH_2)_2$ (*o*) per 100 gms. sat. sol. |
|---|---|
| 35.1... | 4.05 |
| 45.8... | 5.85 |
| 56.3... | 11.86 |
| 61.3... | 18.72 |
| 62.8... | 23.43 |
| 64.2... | 31.55 |
| 66.1... | 46.81 |
| 67.7... | 62.53 |
| 71.3... | 74.74 |
| 80.8... | 88.36 |
| 88.1... | 93.83 |
| 91.7... | 96.15 |
| 95.5... | 97.72 |
| 103.8... | 100.00 |

Results for the two forms of the Meta compound.

| α Form t° | α Form Gms. $C_6H_4(NH_2)_2$ (*m*) per 100 gms. sat. sol. | β Form t° | β Form Gms. $C_6H_4(OH_2)_2$ (*m*) per 100 gms. sat. sol. |
|---|---|---|---|
| 0.3... | 8.71 | 0.3... | 3.27 |
| 4.6... | 12.64 | 14.3... | 9.22 |
| 9.3... | 17.16 | 18.3... | 12.64 |
| 11.7... | 21.21 | 22.0... | 17.16 |
| 16.1... | 32.83 | 24.1... | 21.21 |
| 18.7... | 49.83 | 26.3... | 32.83 |
| 20.8... | 61.94 | 27.1... | 40.62 |
| 22.7... | 69.63 | 27.9... | 49.83 |
| 26.0... | 75.52 | 29.0... | 56.51 |
| 32.6... | 83.83 | 29.1... | 61.94 |
| 43.5... | 92.32 | 30.2... | 69.63 |
| 53.6... | 96.81 | 31.5... | 75.52 |
| 57.6... | 98.40 | 32.8... | 79.15 |
| 62.8... | 100.0 | 34.4... | 83.83 |

Results for the Para compound.

| t° | Gms. $C_6H_4(NH_2)_2$ (*p*) per 100 gms. sat. sol. |
|---|---|
| 3.6... | 1.08 |
| 23.7... | 3.70 |
| 37.8... | 9.85 |
| 49.9... | 18.75 |
| 59.2... | 27.22 |
| 64.6... | 34.43 |
| 69.2... | 41.75 |
| 75.5... | 51.80 |
| 80.3... | 59.02 |
| 88.5... | 70.03 |
| 95.9... | 78.10 |
| 107.0... | 86.63 |
| 125.1... | 95.04 |
| 139.7... | 100.00 |

### Solubility of *o*, *m* and *p* Phenylene Diamines in Benzene.

(Sidgwick and Neill, 1923.)

Results for the Ortho compound.

| t° | Gms. $C_6H_4(NH_2)_2$ (*o*) per 100 gms. sat. sol. |
|---|---|
| 22.2.. | 1.72 |
| 36.0.. | 3.13 |
| 58.4.. | 9.35 |
| 72.1.. | 21.06 |
| 76.9.. | 31.43 |
| 80.0.. | 40.95 |
| 82.5.. | 49.47 |
| 85.6.. | 62.05 |
| 91.1.. | 77.94 |
| 96.8.. | 90.04 |
| 100.1.. | 95.12 |
| 103.8.. | 100.00 |

Results for the Meta compound.

| t° | Gms. $C_6H_4(NH_2)_2$ (*m*) per 100 gms. sat. sol. | t° | Gms. $C_6H_4(NH_2)_2$ (*m*) per 100 gms. sat. sol. |
|---|---|---|---|
| 19.0.... | 1.02 | 58.8... | 72.14 L |
| 34.1.... | 2.84 | 55.5... | 74.56 L |
| 46.8.... | 7.43 | 54.7... | 74.84 L |
| 50.7.... | 9.75 | 53.8 tr.pt. | 75.0 L+S. |
| 59.8.... | 19.36 L | 53.9... | 75.33 |
| 69.0.... | 39.04 L | 54.1... | 76.84 |
| 69.0 crit.t. | – | 54.2... | 78.57 |
| 68.8.... | 50.91 L | 54.7... | 79.31 |
| 66.5.... | 61.60 L | 56.3... | 85.85 |
| 64.2.... | 65.91 L | 57.2... | 88.64 |
| 60.0.... | 71.04 L | 62.8... | 100.00 |

Results for the Para compound.

| t° | Gms. $C_6H_4(NH_2)_2$ (*p*) per 100 gms. sat. sol. |
|---|---|
| 59.1.. | 1.20 |
| 79.9.. | 3.25 |
| 98.5.. | 9.67 |
| 110.6.. | 20.14 |
| 112.9.. | 33.32 |
| 113.9.. | 41.04 |
| 115.2.. | 49.10 |
| 117.1.. | 59.12 |
| 124.0.. | 77.86 |
| 135.5.. | 94.75 |
| 139.7.. | 100.00 |

L indicates two liquid layers; S indicates solid phenylene diamine.

One liter of sat. solution of *p* phenylene diamine in water contains 47.23 gms. $C_6H_4(NH_2)_2$ *p* at 25°. The corresponding figures for aq. 0.2 *n* salt solutions are: KI, 51.68; KBr, 49.68; KCl, 46.85; $K_2SO_4$, 43.21; LiCl, 48.32; NaCl, 47.23.

(Kruyt and Robinson, 1926.)

## PHENYLENE DIAMINES

Freezing-point data are given for mixtures of Phenylene Diamines and:

Acetic acid(15)(19)
Amino phenols(7)
Antipyrine(18)
Anthracene(2)
Benzo hydrol(4)
Benzoic acid(15)(21)(24)
Butyric acid(15)
Cinnamic acid(15)(21)
Dinitro benzene(14)(19)
Dinitro phenol(17)(19)
Dinitro toluene(14)
Dioxy naphthalene(11)
Diphenyl methane(6)
Erythritols(20)
Guaicol(3)
Hydro quinone(14)
Menthol(21)
Naphthalene(2)
Nitroso dimethyl aniline
Naphthols (14) (25)
Phenanthrene(2)
Phenol(12)
Phenylene diamines(21)
Phloro glucinol(5)
Pyrocatechol(5)(14)
Pyrogallol(16)(1)(5)
Resorcinol(14)
Salicylic acid(15)
Salol(21)
Sarcosine anhydride(22)
Succinic acid(15)
Trinitro benzene(8)
Trinitro toluene(8)
Thymol(21)
Triphenyl carbinol(10)
Triphenyl methane(9)(13)(23)

(1) Beets, 1937; (2) Bernoulli and Lotter, 1933; (3) Dezelic, 1932; (4) Kremann and Drazil, 1924; (5) Naegeli and Kaltman, 1933; (6) Kremann and Fritsch, 1920; (7) Kremann and Hohl, 1920; (8) Kremann and Mauermann, 1922; (9) Kremann, Mauermann, Müller and Rösler, 1923; (10) Kremann, Hohl and Müller II, 1921; (11) Kremann, Hemmelmayr and Riemer, 1922; (12) Kremann and Petritschek, 1917; (13) Kremann, Odelga and Zawodsky, 1921; (14) Kremann and Strohschneider, 1918; (15) Kremann, Weber and Zechner, 1925; (16) Kremann and Zechner, 1918; (17) Kremann and Zawodsky, 1921; (18) Pfeiffer and Angern, 1926; (19) Puschin and Rikovski,1930; 1932a; (20) Puschin and Dezelic, 1932; (21) Puschin and Dezelic, 1938; (22) Pfeiffer, Angern and Wang, 1927; (23) Rheinboldt and Kirscheisen, 1926; (24) Puschin and Wilowitsch, 1925; (25) Kremann and Wlk, 1919.

## METHYL BARBITAL (Methyl Veronal) $\underline{NHCONHCOC(CH_3)_2CO}$.

Freezing-point data for mixtures of methyl barbital and pyramidon and for methyl barbital and sarcosine anhydride are given by Pfeiffer and Seydel, 1928.

## FUMARIC ACID DIMETHYL ESTER $(:CHCOOCH_3)_2$.
## MALEIC ACID DIMETHYL ESTER $(:CHCOOCH_3)_2$.

100 gms. ligroine dissolve 0.018 gm. trans fumaric acid di methyl ester at $-39^\circ$.

100 gms. ligroine dissolve 0.031 gm. cis maleic acid di methyl ester at $-39^\circ$. (Wasserman, 1930.)

Freezing-point data are given for mixtures of:

| | | | |
|---|---|---|---|
| Fumaric acid Dimethyl Ester | + Dimethyl Succinate | (Viseur, 1926.) | |
| " " " " | + Diphenyl Butadien | (Kuhn and Wagner-Jauregg, | |
| Maleic " " " | + Dimethyl Succinate | (Viseur, 1926.) | (1929.) |
| Fumaric acid Ethyl Ester | + Ethyl Succinate | " | " |
| Maleic " " " | + " " | " | " |
| " " " " | + " Formate | " | " |
| " " " " | + Methyl " | " | " |

## Sodium TRICARBALLATES.

| Solvent | $t^\circ$ | Compound | Gms. compound per 100cc solvent | |
|---|---|---|---|---|
| Aq. 60 Vol.% $C_2H_5OH$ | 23-25 | $(CH_2)_2CH(COOH)_2(COONa)$ | 6.23 | (McDermott, 1940. |
| " 67 " " | " | $(CH_2)_2CH(COOH)(COONa)_2$ | 5.18 | " " |
| " 58 " " | " | $(CH_2)_2CH(COONa)_3$ | 3.21 | " " |

## CITRIC ACID $(CH_2)_2COH(COOH)_3.H_2O$.

### Solubility of Citric Acid in Water, Determined by the Freezing-Point Method. (Kremann and Eitel, 1923.)

| t° of crystallization. | Gms. $(CH_2)_2COH(COOH)_3$ per 100 gms. sat. sol. | Solid Phase. | t° of crystallization. | Gms. $(CH_2)_2COH(COOH)_3$ per 100 gms. sat. sol. | Solid Phase. |
|---|---|---|---|---|---|
| — 0.9..... | 7.95 | Ice | —11.30..... | 45.71 | Ice |
| — 1.67.... | 12.59 | » | —11.8 (Eutectic. | 46.47 | »+$(CH_2)_2COH(COOH)_3.H_2O$ |
| — 1.60.... | 13.81 | » | —12.63..... | 47.35 | Ice (unstable) |
| — 2.40.... | 18.53 | » | —12.81..... | 48.14 | » |
| — 3.00.... | 21.37 | » | —10.20..... | ÷ | $(CH_2)_2COH(COOH)_3.H_2O$ |
| — 3.78.... | 25.46 | » | — 8.5..... | 49.93 | » |
| — 4.87.... | 29.26 | » | — 3.0..... | 54.30 | » |
| 5.40.... | 32.05 | » | + 1.6..... | 56.31 | » |
| — 6.3..... | 34.93 | » | 1.2..... | 56.56 | » |
| — 7.91.... | 38.54 | » | 0.0..... | 56.77 | » |
| 8.00.... | 39.89 | » | 10.8..... | 58.78 | » |
| 8.73.... | 41.50 | » | 10.0..... | 59.30 | » |
| —10.45.... | 43.83 | » | 15.0..... | 59.06 | » |

Freezing-point data are also given for the ternary mixture citric acid + sugar + water.

### Solubility of Citric Acid in Water, Determined by Titration of the Saturated Solutions.

(Dalman, 1937a.)

| t° | Gms. $C_6H_7O_7$ per 100 gms. sat. sol. | Solid Phase | t° | Gms. $C_6H_7O_7$ per 100 gms. sat. sol. | Solid Phase |
|---|---|---|---|---|---|
| 0 | 48.956(48.72) | $C_6H_7O_7.H_2O$ | 35.8tr.pt. | 67.222 | $C_6H_7O_7.H_2O + C_6H_7O_7$ |
| 5 | 51.571(51.21) | " | 40 | 68.320 | $C_6H_7O_7$ |
| 10 | 54.187(54.68) | " | 50 | 70.936 | " |
| 15 | 56.802(60.34) | " | 60 | 73.552 | " |
| 20 | 59.418 | " | 70 | 76.168 | " |
| 25 | 62.033 | " | 80 | 78.784 | " |
| 30 | 64.658 | " | 90 | 81.400 | " |
| 35.8tr.pt. | 67.683 | " + $C_6H_7O_7$. | 100 | 84.017 | " |

The results in parentheses are by Guttmann and Klewa, 1927.

### Solubility of Citric Acid at 25° in Aqueous Solutions of:

Phosphorus Acid ($H_3PO_3$)
(Redfield and King, 1936.)

| Normality of Aq. $H_3PO_3$ | Normality of dissolved $C_6H_8O_7$ |
|---|---|
| 0.0 | 12.61 |
| 6.18 | 11.42 |
| 11.64 | 9.13 |
| 15.21 | 8.07 |
| 21.01 | 6.15 |
| 25.61 | 5.12 |
| 30.77 | 3.70 |
| 37.38 | 2.66 |
| 41.42 | 2.22 |

Phosphoric Acid ($H_3PO_4$)
(Walton and Kepfer, 1930.)

| Normality of Aq. $H_3PO_4$ | Normality of dissolved $C_6H_8O_7$ |
|---|---|
| 0.0 | 12.54 |
| 5.32 | 9.88 |
| 13.02 | 6.61 |
| 16.61 | 5.23 |
| 23.44 | 2.89 |
| 33.14 | 1.20 |
| 34.92 | 1.02 |
| 36.10 | 0.96 |
| 39.70 | 0.92 |

SOLUBILITY OF CITRIC ACID IN AQUEOUS SOLUTIONS OF HYDROCHLORIC ACID AT 25°. (Knox and Richards, 1919.)

| Equivalent Normality. | |
|---|---|
| HCl. | $C_6H_8O_7$. |
| 0.0 | 12.54 |
| 0.949 | 11.03 |
| 2.189 | 9.30 |
| 3.795 | 7.36 |
| 5.718 | 5.38 |
| 7.736 | 4.09 |
| 9.635 | 3.46 |
| 10.36 | 3.35 |
| 11.09 | 3.29 |

SOLUBILITY OF CITRIC ACID IN AQUEOUS SOLUTIONS OF SULFURIC ACID AT 25° (Knox and Richards, 1919.)

| Equivalent Normality. | |
|---|---|
| $H_2SO_4$. | $C_6H_8O_7$. |
| 1.689 | 10.57 |
| 4.206 | 7.97 |
| 7.145 | 5.61 |
| 10.83 | 3.28 |
| 11.46 | 3.07 |
| 14.24 | 2.23 |
| 18 18 | 1.76 |
| 20.59 | 2.00 |
| 22.37 | 2.88 |

100 gms para cymene (b. pt. 176°-176°.5) dissolve 0.034 gm. citric acid at 25°. (Wheeler, 1920.)

SOLUBILITY OF HYDRATED AND OF ANHYDROUS CITRIC ACID, DETERMINED SEPARATELY, IN AQUEOUS SOLUTIONS OF ETHYL ALCOHOL AT 25°. (Seidell, 1910.)

Results for Hydrated Citric Acid.

| Wt. % $C_2H_5OH$ in Solvent. | $d_{25}$ of Sat. Sol. | Gms. $(CH_2)_2COH(COOH)_3.H_2O$ per 100 Gms. Sat. Solution. |
|---|---|---|
| 0 | 1.311 | 67.5 |
| 20 | 1.286 | 66 |
| 40 | 1.257 | 64.3 |
| 50 | 1.237 | 63.3 |
| 60 | 1.216 | 62 |
| 70 | 1.192 | 60.8* |
| 80 | 1.163 | 58.1* |
| 90 | 1.125 | 54.7* |
| 100 | 1.068 | 49.8* |

Results for Anhydrous Citric Acid.

| Wt. % $C_2H_5OH$ in Solvent. | $d_{25}$ of Sat. Sol. | Gms. $(CH_2)_2COH(COOH)_3$ per 100 Gms. Sat. Solution. |
|---|---|---|
| 20 | 1.297 | 62.3 |
| 40 | 1.246 | 59 |
| 60 | 1.190 | 54.8 |
| 70 | 1.160 | 52.2 |
| 80 | 1.120 | 48.5 |
| 90 | 1.065 | 43.7 |
| 100 | 1.010 | 38.3 |

* Solid phase dehydrated more or less completely.

SOLUBILITY OF HYDRATED AND OF ANHYDROUS CITRIC ACID, DETERMINED SEPARATELY, IN SEVERAL ORGANIC ACIDS AT 25°. (Seidell, 1910.)

Results for Hydrated Citric Acid.

| Solvent. | $d_{25}$ of Sat. Sol. | Gms. $(CH_2)_2COH(COOH)_3.H_2O$ per 100 Gms. Sat. Sol. |
|---|---|---|
| Amyl Acetate of $d_{20}$=0.8750 | 0.8917 | 5.980 |
| Amyl Alcohol of $d_{20}$=0.8170 | 0.8774 | 15.430 |
| Ethyl Acetate of $d_{25}$=0.8915 | 0.9175 | 5.276 |
| Ether (abs.) of $d_{22}$=0.7110 | 0.7228 | 2.174 |
| Chloroform of $d_{22}$=1.476 | 1.4850 | 0.007 |

Results for Anhydrous Citric Acid.

| Solvent. | $d_{25}$ of Sat. Sol. | Gms. $(CH_2)_2COH(COOH)_3$ per 100 Gms. Sat. Sol. |
|---|---|---|
| Amyl Acetate | 0.8861 | 4.22 |
| Ether (abs.) | 0.7160 | 1.05 |
| Chloroform | 1.4880 | 0 |
| $C_6H_6$, $CS_2$ | | |
| $CCl_4$ or $C_6H_5CH_3$ | ... | 0 |

100 gms. 95% formic acid dissolve 12.25 gms. citric acid at 20°. (Aschan, 1913.)
100 gms. dichlorethylene dissolve 0.005 gm. citric acid at 15°. (Wester & Bruins, '14.)
" trichlorethylene " 0.012 " " " " " " " "
" methyl alcohol " 197 gms. " " " " 19°. (Timofeiew, 1914.)
" propyl alcohol " 62.8 " " " " " " "

DISTRIBUTION OF CITRIC ACID BETWEEN WATER AND ETHER. (Pinnow, 1915.)

Results at 15°.

| Mols. Citric Acid per Liter. | | Dist. Coef. |
|---|---|---|
| In $H_2O$ Layer. | In Ether Layer. | |
| 0.902 | 0.0077 | 117 |
| 0.460 | 0.0036 | 128 |
| 0.220 | 0.0017 | 129 |
| 0.297 | 0.0023 | 129 |

Results at 25.5°.

| Mols. Citric Acid per Liter. | | Dist Coef. |
|---|---|---|
| In $H_2O$ Layer. | In Ether Layer. | |
| 0.9175 | 0.0063 | 114 |
| 0.481 | 0.0031 | 155 |
| 0.241 | 0.00155 | 155 |
| 0.315 | 0.0020 | 158 |

DISTRIBUTION OF CITRIC ACID BETWEEN WATER AND ISO AMYL ALCOHOL AT 25°.
(Kolossowsky, Kulikow and Bekturow, 1935.)

| Gm. Mols. $C_6H_8O_7$ per liter | | $\frac{1}{2}$ | Gm. Mols. $C_6H_8O_7$ per liter | | $\frac{1}{2}$ |
|---|---|---|---|---|---|
| $H_2O$ layer(1) | Alcohol layer(2) | | $H_2O$ layer(1) | Alcohol layer(2) | |
| 0.0936 | 0.0150 | 6.31 | 3.7800 | 0.8379 | 4.54 |
| 1.4805 | 0.2797 | 5.29 | 5.2794 | 1.2033 | 4.39 |
| 1.5930 | 0.3087 | 5.16 | 7.2198 | 1.9215 | 3.76 |
| 2.0286 | 0.4095 | 4.95 | 8.4559 | 2.8476 | 2.97 |
| 2.5641 | 0.5418 | 4.73 | 9.7020 | 3.6792 | 2.64 |
| 3.2004 | 0.7256 | 4.41 | 11.1510 | 4.8888 | 2.28 |

Sodium CITRATES

| Solvent | t° | Compound | Gms. compound per 100cc solvent | |
|---|---|---|---|---|
| 94 Vol. % $C_2H_5OH$ | 23-25 | $(CH_2)_2COH(COONa)_3.5\frac{1}{2}H_2O$ | 0.0047 | (McDermott, |
| " " " | " | $(CH_2)_2COH(COOH(COONa)_2.?H_2O$ | 0.0207 | " 1940.) |
| " " " | " | $(CH_2)_2COH(COOH)_2(COONa).?H_2O$ | 0.0527 | " |

D MANNITOL HEXANITRATE $C_6H_8(NO_3)_6$.

Freezing-point data are given by Urbanski, 1933, 1934, for mixtures of D Mannitol hexanitrate and each of the following compounds:

| | | |
|---|---|---|
| Diethyl diphenyl urea | Naphthalene | Nitro erythritol |
| Dimethyl diphenyl urea | Nitro aniline | Nitro naphthalene |
| Dinitro anisole | Nitro anisole | Nitro penta erythritol |
| Dinitro benzene | Nitro benzaldehyde | Nitro phenetol |
| Dinitro chloro benzene | Nitro benzoic acid | Nitro phenol |
| Dinitro toluene | ethyl ester | Nitro toluene |
| Hydroquinone dimethyl ether | Nitro chloro benzene | Trinitro benzene |
| | | Trinitro toluene |

ETHYL SUCCINIMIDE $(CH_2CO)_2NC_2H_5$.

Freezing-point data for mixtures of ethyl succinimide and bromo toluene and of ethyl succinimide and p xylene are given by Paterno and Ampola, 1897.)

METHYL CYCLOPENTANE $C_5H_7.CH_3$.

The critical solution temperature of mixtures of methyl cyclopentane and sulfur dioxide is 8° and the reciprocal solubility curve at this temperature is practically flat between the concentrations 45 and 90 gm. mol. percent $SO_2$. (Leslie, 1934.)

DI ALLYL ETHER $(C_3H_5)_2O$.

RECIPROCAL SOLUBILITY OF DI ALLYL ETHER AND WATER.
(Bennett and Philip, 1928.)

The determinations were made by the method of Hill, 1923, modified by reducing the scale of the apparatus to require only 4-5cc of each liquid, and adding a globule of Hg to hasten mixing.

| t° | Wt.% $(C_3H_5)_2O$ in Aq. Phase | Wt.% $H_2O$ in Ether phase | t° | Wt.% $(C_3H_5)_2O$ in Aq. Phase | Wt.% $H_2O$ in Ether phase |
|---|---|---|---|---|---|
| 0 | 11.68 | 0.71 | 20 | 9.18 | 1.25 |
| 10 | 10.20 | 0.91 | 25 | 8.86 | 1.51 |
| 15 | 9.61 | 1.05 | | | |

**CYCLOHEXANONE** $(CH_2)_5:CO$.

Freezing-point data for mixtures of cyclohexanone and phenol are given by Schmidlin and Lang, 1910.

**SARCOSINE ANHYDRIDE** $(CH_3N.CH_2CO)_2$.

Freezing-point are given for mixtures of sarcosine anhydride and di phenyl amine by Pfeiffer and Angern, 1926. Results for mixtures of sarcosine anhydride and each of the following compounds are given by Pfeiffer and Seydel, 1928b: o amino phenol, m amino benzoic acid methyl ester, p oxy benzoic acid methyl ester and orthoform. For other results see Sarcosine, $C_3H_7O_2N$.

**Di ETHYL OXALATE** $(COOC_2H_5)_2$.

Freezing-point data for mixtures of diethyl oxalate and hydroquinol, resorcinol and β naphthol are given by Kremann, Zechner and Drazil, 1924. Results for mixtures of diethyl oxalate and trichlor acetic acid are given by Kendall and Booge, 1916.

**Di METHYL SUCCINATE** $(CH_2)_2(COOCH_3)_2$.

Freezing-points are given for :

Dimethyl succinate + Acetic acid (Kendall and Booge, 1916.)
" " + Acetylene methyl-tetra carbonate (Timmermans and Vesselovsky, 1931.)
" " + Chlor acetic acid (Kendall and Booge, 1916.)
" " + Methyl fumarate (Viseur, 1926.)
" " + Methyl maleate " "
" " + Succino nitrile (Timmermans and Vesselovsky, 1931.)
" " + Tri chlor acetic acid (Kendall and Booge, 1916.)

**n PROPYL MALONIC ACID** $CH(C_3H_7)(COOH)_2$.

100 gms. $H_2O$ dissolve 202.2 gm. $CH(C_3H_7)(COOH)_2$ at 25°.
100 gms. $C_6H_6$ dissolve 0.052 gm. $CH(C_3H_7)(COOH)_2$ at 25°.
(Verkade and Coops, 1930a.)

**ADIPIC ACID** (Normal) $(CH_2)_4(COOH)_2$.

100 grams $H_2O$ dissolve 1.44 grams adipic acid at 15°.
(Henry — Compt. rend., 99, 1157, '84; Lamouroux — *Ibid.*, 128, 998, '99.)

100 grams of formic acid (95% HCOOH) dissolve 4.04 grams of $(CH_2)_4(COOH)_2$ at 18.5°; 100 cc. of the saturated solution contain 4.684 grams of the acid. (Aschan, 1913.)

Diagrams showing the solubility of adipic acid in binary mixtures of water, acetone, methyl alcohol, ethyl alcohol, propyl alcohol and carbon tetrachloride at 20° and at 40° are given by Bancroft and Butler, 1932.

Sodium **ADIPATES.**

SOLUBILITY OF EACH SEPARATELY IN AQUEOUS ETHYL ALCOHOL AT 23-25°.
(McDermott, 1940.)

| Salt | Vol.% $C_2H_5OH$ in Solvent | Gms. salt per 100cc solvent |
|---|---|---|
| $(CH_2)_4(COOH)COONa.H_2O$ | 65.8 | 3.88 |
| $(CH_2)_4(COONa)_2$ | 60.0 | 3.00 |

**METHYL MALATE** $CH_2CH(OH)(COOCH_3)_2$.

Freezing-point data for mixtures of methyl malates and methyl tartrates and methyl chloro succinate are given by Timmermans and Mme. Vesselovsky, 1932.

**GLYCOGEN** $(C_6H_{10}O_5)_x$.

SOLUBILITY OF GLYCOGEN IN WATER.
(Kerley 1930.)

Since the usual method of preparing glycogen by boiling tissue with 60% KOH appeared to affect its solubility, samples were prepared by dehydration with alcohol and subsequent extraction with water. Samples prepared without boiling with alkali, take from 3 to 4 days to reach saturation in water. Similar samples boiled for 2½ hours with 60% potassium hydroxide reached a slightly higher solubility value within a few hours. The solubility determinations were made under sterile conditions. Successive small portions of the saturated solutions were withdrawn at intervals and analyzed by a micro modification of Pfluger's method of estimating glycogen.

| Sample employed | t° | Gms. glycogen dissolved per 100 gms. sat. sol. |
|---|---|---|
| Muscle glycogen not boiled with KOH | 0 | 16.0 |
| " " " " " " | 20 | 17.7 |
| " " " " " " | 37 | 40.0+ |
| Frog muscle glycogen | 20 | 14.9 |
| Rabbit liver glycogen | 20 | 21.0 |

Glycogen is slightly soluble in aqueous alcohol. Results are given showing the decreasing solubility of glycogen with increasing concentration of alcohol in presence of potassium acetate, potassium trichlor acetate, potassium hydroxide and trichlor acetic acid.

**BROMURAL** (α Bromo Iso Valerylurea) $NH_2.CO.NH.COCHBrCH(CH_3)_2$.

Freezing-point data are given for mixtures of:

Bromural + Salol (Hrynakowski and Szmyt, 1935d.)
" + Phenacetine " " "
" + Pyramidon (Sandquist and Hök, 1927.

## UREIDES $C_6H_{11}O_2N_2Br$.

SOLUBILITY OF SEVERAL UREIDES, EACH SEPARATELY, IN WATER AND IN OIL AT (?) TEMPERATURE.
(Fourneau and Florence, 1928.)

| Ureide of: | Gms. Ureide per 100 gms. sat. solution in: Water | Oil |
|---|---|---|
| α Bromo-n-Valeric acid | 0.833 | 0.26 |
| β " " " " | 0.78 | 0.19 |
| γ " " " " | 0.97 | 0.22 |
| α " iso " " | 1.94 | — |
| 2, " Methyl ethyl acetic acid | 5.3 | 3.53 |
| β " α ethyl propionic acid | 4.01 | 1.84 |
| 3, " 2-methyl butanoic acid | 3.2 | 1.01 |
| γ " α " " " | 1.05 | 0.92 |
| " pivalic acid | 5.4 | — |

## BUTYL OXAMATE *iso* $CONH_2COO.(CH_3)_2CHCH_2$.

Freezing-point lowering data for binary and ternary mixtures of iso butyl, methyl and ethyl oxaminic acid Esters are given by Praetorius, 1924.

## TRIGLYCINE $NH_2CH_2CONHCH_2CONHCH_2COOH$.

SOLUBILITY OF TRIGLYCINE IN AQUEOUS ETHYL ALCOHOL AT 25°.
(McMeekin, Cohn and Weare, 1936.)

| Solvent | d. of sat. sol. | Gm. Mols. $C_6H_{11}O_4N_3$ per liter |
|---|---|---|
| Water | 1.0229 | 0.309 |
| Aq. 80% $C_2H_5OH$ | 0.8554 | 0.000608 |
| Aq. 90% $C_2H_5OH$ | 0.8249 | 0.0000381 |
| Aq. 100% $C_2H_5OH$ | 0.7851 | 0.00000106 |

## CYCLOHEXANE $C_6H_{12}$.

SOLUBILITY OF WATER IN CYCLOHEXANE.
(Tarassenkow and Poloshinzewa, 1932.)

| t° | Gms. $H_2O$ per 100 gms. sat. sol. in $C_6H_{12}$ | t° | Gms. $H_2O$ per 100 gms sat. sol. in $C_6H_{12}$ |
|---|---|---|---|
| 14 | 0.005 | 32.5 | 0.020 |
| 19 | 0.010 | 38.0 | 0.031 |
| 28.5 | 0.015 | 53.0 | 0.050 |

## TETRA METHYL THIURAM SULFIDE $[(CH_3)_2NCS]_2$.

Determinations of the solubility of tetra methyl thiuram sulfides (sulfide, bis (dimethyl thio carbamyl) and other compounds in rubber, by means of microscope examinations of prepared samples are described by Morris, 1932.

**CYCLOHEXANE** (Hexamethylene, Hexahydrobenzene) $CH_2<(CH_2.CH_2)_2>CH_2$.

THE MUTUAL SOLUBILITY OF CYCLOHEXANE AND METHYL ALCOHOL.
(Timmermans, 1912.)

The following determinations of the critical temperature of solution at high pressures are given. The constants of the cyclohexane were : b. pt. 80°.75; f. pt. + 6°.5. The methyl alcohol was rendered anhydrous by distilling over sodium.

| Pressure in kilogm. | Critical temp. of solution. | Pressure in kilogm. | Critical temp. of solution. |
|---|---|---|---|
| 50..... | 59.45 | 400..... | 69.10 |
| 100..... | 61.02 | 700..... | 75.26 |
| 200..... | 63.98 | 1000..... | 81.0 |

The triphase system crystallizes at + 5°.

RECIPROCAL SOLUBILITY OF CYCLOHEXANE AND LIQUID SULFUR DIOXIDE.
(Seyer and Dunbar, 1922.)

The cyclohexane had a boiling point of 79° and freezing-point of + 6.4. It was dried by refluxing over sodium. The $SO_2$ was the ordinary commercial product carefully freed of $H_2O$. Weighed amounts of the two constituents were sealed in bulbs of about 15 cc. capacity and the temperatures at which two distinct layers or cyclohexane crystals just appear, were determined.

Solubility of the Two Liquids.

| t°. | Wt. per cent $SO_2$. | t°. | Wt. per cent $SO_2$. |
|---|---|---|---|
| — 1.0.. | 18.0 | 13.3... | 65.4 |
| + 1.5... | 22.0 | 8.8... | 83.2 |
| 11.0... | 35.0 | 4.0... | 87.9 |
| 11.3... | 40.9 | —6.0... | 92.2 |
| 13.5... | 59.2 | —8.5... | 94.0 |

Temperatures at Which Cyclohexane Crystals Appear.

| t°. | Wt. per cent $SO_2$. | t°. | Wt. per cent $SO_2$. |
|---|---|---|---|
| — 4.3... | 4.0 | About —51.0... | 98.4 |
| —17.0... | 18.0 | —56.0... | 99.0 |
| —17.0... | 22.0 | —60.0... | 99.2 |
| —24.3... | 96.0 | —6045... | 99.5 |
| —34.2... | 97.5 | —72.5 (Eutectic) | — |

The critical solution temperature of mixtures of cyclohexane and liquid sulfur dioxide is 12° and the reciprocal solubility curve is practically flat between the concentrations 40 and 90 mol. percent $SO_2$.
(Leslie, 1934.)

The critical solution temperature of mixtures of cyclohexane and aniline is 31°. The calculated critical solution temperature of mixtures of cyclohexane and m toluidine is -18°. (Dessart, 1926.)

The critical solution temp of cyclohexane + propionitrile is 12°.2 and the mixture contains 70 per cent of cyclohexane. (Hortenberg, 1926.)

The critical solution temp of methylcyclohexane and *o* toluidine is — 5°.6 and the mixture contains 45.5 per cent methyl cyclohexane. (Hortenberg, 1926.)

Numerical data are given by Dessart, 1926, for the curve of separation in the system methyl cyclohexane + *m* toluidine.

Freezing-point data are given for mixtures of Cyclohexane and:

Acetic acid(1)
Aniline(2)(6)
Azobenzene(7)
Benzene(12)
Benzoin(11)
Carbon disulfide(4)
Carbon tetrachloride(10)
Chloroform(10)
Dicetyl (dotria contane(9)
Ethylene bromide(1)
Hexane(10)
Methyl alcohol(5)
Methyl cyclohexane(10)
Naphthalene(6)
Nitro benzene(6)
Nitro toluenes(6)(3)
Piperidine(8)
Proprio nitrile(5)
Toluene(10)
Toluidines(3)(5)(6)

(1) Baud, 1913(a)(b); (2) Deffet, 1938; (3) Dessart, 1926; (4) Hirshberg, 1932; (5) Lecat, 1909; (6) Linard, 1925; (7) Pascal and Normand, 1913; (8) Mascarelli and Constantino, 1909, 1910; (9) Seyer, 1938; (10) Timmermans, 1928; (11) Vanstone, 1913; (12) Mascarelli and Pestalozza, 1907, 1908.

**HEXAMETHYLENE TETRAMINE** $(CH_2)_6N_4$.

100 gms. $H_2O$ dissolve 81.32 gms. $(CH_2)_6N_4$ at 12°. (Delepine, 1895.)
100 gms. abs. alcohol dissolve 3.22 gms. $(CH_2)_6N_4$ at 12°. "
100 cc. 90% alcohol dissolve 12.5 gms. $(CH_2)_6N_4$ at 15–20°. (Squire and Caines, 1905.)
100 gms. $CHCl_3$ dissolve 8.09 gms. $(CH_2)_6N_4$ at 12°. (Delepine, 1895.)

Solubility of Hexamethylene Tetramine in Several Solvents at Ordinary Temperature. (Utz, 1919.)

| Solvent. | Gms. $(CH_2)_6N_4$ per 100 gms. solvent. | Solvent. | Gms. $(CH_2)_6N_4$ per 100 gms. solvent. |
|---|---|---|---|
| Water | 167.0 | Carbon tetrachloride | 0.85 |
| Ethyl ether | 0.06 | Amyl alcohol | 1.84 |
| Trichlor ethylene | 0.11 | Absolute alcohol | 2.89 |
| Xylene | 0.14 | 90 % alcohol | 5.58 |
| Carbon disulfide | 0.17 | Methyl alcohol | 7.25 |
| Benzene | 0.23 | Chloroform | 13.40 |
| Tetrachlor ethane | 0.50 | 86.5% glycerol ($d$=1.2326). | 26.50* |
| Acetone | 0.65 | 98.5% " ($d$=1.2645). | 20.9* |

* Holm, 1921, 1922.

100 gms. glycol diacetate dissolve about 0.9 gm. HEXA METHYLENE TRIPEROXIDE DIAMINE at 25°. (Taylor and Rinkenbach, 1926.)

$\alpha$ and $\beta$ **TRITHIOACETALDEHYDE**, $(CH_3CHS)_3$.

$\alpha$ and $\beta$ **TRITHIOBENZALDEHYDE**, $(C_6H_5CHS)_3$.

Solubility of each (Determined Separately) in Several Solvents at 25°.
(Suyver, 1905.)

| Solvent. | Gms. per 100 Gms. Solvent. | | | |
|---|---|---|---|---|
| | $\alpha$ $(CH_3CHS)_3$. | $\beta$ $(CH_3CHS)_3$. | $\alpha$ $(C_6H_5CHS)_3$. | $\beta$ $(C_6H_5CHS)_3$. |
| Ether | 15.58 | 13.67 | 1.09 | 0.37 |
| Ethyl Alcohol | 3.86 | 3.97 | 0.20 | 0.04 |
| Methyl Alcohol | 4.04 | 3.89 | 0.17 | 0.04 |
| Acetone | 20.96 | 18.31 | 2.45 | 1.12 |
| Chloroform | 57.59 | 51.22 | 11.11 | 0.20 |
| Carbon Disulfide | 25.50 | 20.75 | 5.81 | 0.22 |
| Benzene | 36.40 | 26.98 | 6.08 | 0.014 |
| Ethyl acetate | 17.52 | 15.48 | 2.05 | 0.93 |

Data for the solidification points of mixtures of $\alpha$ and $\beta$ trithioacetaldehyde are also given. Similar data for mixtures of $\alpha$ and $\beta$ trithiobenzaldehyde could not be determined on account of decomposition with production of resins.

**CYCLOHEXANOL** $(CH_2)_5.CHOH$.

100 gms. $H_2O$ dissolve 5.67 gms. cyclohexanol at 11°. (de Forcrand, 1912.)
100 gms. cyclohexanol dissolve 11.27 gms. $H_2O$ at 11°. "

Reciprocal Solubility of Cyclohexanol and Water, Determined by the Freezing-point Method.
(de Forcrand, 1912.)

| t° of Solidification. | Gm. $(CH_2)_5.CHOH$ per 100 Gms. Mixture. | t° of Solidification. | Gm. $(CH_2)_5CHOH$ per 100 Gms. Mixture. |
|---|---|---|---|
| +22.45 | 100 | −57.4 Eutec. | 95.030 |
| 17.48 | 99.767 | −43.2 | 93.150 |
| − 1.40 | 98.817 | −33 | 91.962 |
| −34.10 | 96.868 | −18.50 | 90.980 |
| −46.80 | 95.910 | −14.58 | 90.36 |
| −55.70 | 95.170 | −12.05 | 88.73 |

Freezing-point data for mixtures of cyclohexanol and phenol are given by Mascarelli and Pestalozza, 1908, 1909.

## CYCLOHEXANOL

### Equilibrium in the System Cyclohexanol and Water.
(Sidgwick and Sutton, 1930.)

The determinations were made by the synthetic method. In the case of the portion of curve where solid cyclohexanol separated, 88-93%, the mixtures were super cooled and then warmed slowly and the temperature noted at which only a trace of solid remained.

| t° | Wt. Percent $C_6H_{11}OH$ in sat. solution | t° | Wt. Percent $C_6H_{11}OH$ in sat. solution | t° | Wt. Percent $C_6H_{11}OH$ in sat. solution |
|---|---|---|---|---|---|
| -0.3 | 1.67(1) | 7.2 | 5.0 | 121.95 | 5.14 |
| -0.6 | 3.33(1) | 9.7 | 4.58 | 156.9 | 9.22 |
| -0.9 | 5.00(1) | 15.2 | 4.29 | 174.3 | 15.00 |
| -1.2 | 88.3 (2) | 20.6 | 3.82 | 184.7 | 32.4 |
| -2.0 | 89.0 (2) | 28.7 | 3.57 | 183.7 | 52.3 |
| -4.9 | 90.45(2) | 31.85 | 3.37 | 180.1 | 59.4 |
| -7.6 | 91.2 (2) | 40.4 | 3.26 | 163.0 | 70.1 |
| -10.2 | 92.3((2) | 66.3 | 3.19 | 130.9 | 80.2 |
| -15.1 | 93.0 (2) | 70.45 | 3.18 | 93.6 | 85.3 |
| | | 82.4 | 3.37 | 51.55 | 87.9 |

(1) Solid phase, Ice; (2) Solid phase, Chclohexanol.

The existence of the solid hydrate described by Forcrand was not confirmed.

100 gms. $H_2O$ dissolve 6.0 gms. cyclohexanol at 20°. (Smith, 1932.)

100 gms. of aq. 0.4 normal sodium oleate solution (= 10.8 gm. Na oleate per 100 gms. solution) dissolve 59.0.gms. cyclohexanol at 20°. (Smith, 1932.)

**1-HEXENE-3-OL** $CH_2{:}CH.CH(OH)CH_2.CH_2CH_3$.

**4-HEXENE-3-OL** $CH_3.CH_2CH(OH)CH{:}CHCH_3$(?)

**2-METHYL PENTENE-3-OL** $CH_2{:}C(CH_3)CH(OH)CH_2CH_3$(?)

### Reciprocal Solubility of Each of the Above Unsaturated Alcohols in Water.
(Ginnings, Herring and Coltrane, 1939.)

The authors describe the preparation of each of the alcohols but do not give the structural formulas.

| Compound | t° | Density of the: | | Gms. Alcohol per 100 gms.: | |
|---|---|---|---|---|---|
| | | $H_2O$ rich phase | Alcohol rich phase | $H_2O$ rich phase | Alcohol rich phase |
| 1-Hexene-3-ol | 20 | 0.9953 | 0.8466 | 2.72 | 94.12 |
| " " | 25 | 0.9944 | 0.8430 | 2.52 | 93.92 |
| " " | 30 | 0.9936 | 0.8376 | 2.36 | 93.90 |
| 4-Hexene-3-ol | 20 | 0.9936 | 0.8559 | 4.06 | 96.07 |
| " " | 25 | 0.9928 | 0.8524 | 3.81 | 95.85 |
| " " | 30 | 0.9917 | 0.8480 | 3.58 | 95.74 |
| 2-Methyl Pentene-3-ol | 20 | 0.9947 | 0.8535 | 3.29 | 94.16 |
| " " " | 25 | 0.9938 | 0.8494 | 3.06 | 94.10 |
| " " " | 30 | 0.9926 | 0.8451 | 2.89 | 93.97 |

**METHYL n BUTYL KETONE** (2-HEXANONE) $CH_3CO(CH_2)_3CH_3$.

**METHYL Iso BUTYL KETONE** (2- Pentanone-4-methyl) $CH_3COCH_2CH(CH_3)_2$.

SOLUBILITY OF EACH SEPARATELY IN WATER.

(Gross, Rintelen and Saylor, 1939.)

The saturated solutions were analyzed by means of a Zeiss combination liquid and gas interferometer.

| $t^\circ$ | Gm. Mols. 2-Hexanone per 1000 gms. $H_2O$ | Gm. Mols. 2-Pentanone-4-methyl per 1000 gms. $H_2O$ |
|---|---|---|
| 0 | — | 0.307 |
| 10 | 0.204 | 0.231 |
| 30 | 0.145 | 0.166 |
| 50 | 0.124 | 0.141 |
| 75 | — | 0.137 |

100 gms. sat. solution of methyl butyl ketone in water contain 3.44 gm. $C_6H_{12}O$ at 25°.

100 gms. sat. solution of $H_2O$ in methyl butyl ketone contain 3.7 gms. $H_2O$ at 25°. (Park and Hofmann, 1932.)

**PINACOLIN** $CH_3.CO.C(CH_3)_3$.

SOLUBILITY IN WATER AND IN AQ. ACETONE AT 15°. (Delange, 1908.)

| Per cent Acetone in Solvent. | cc. Pinacolin Dissolved per 100 cc. Solvent. |
|---|---|
| 0 (= pure $H_2O$) | 2.44 |
| 20 | 3.47 |
| 33 | 6.06 |
| 50 | 9.09 |
| 60 | 14.27 |

**AMYL FORMATE** $HCOO(CH_2)_4CH_3$.

SOLUBILITY OF AMYL FORMATE IN AQUEOUS ETHYL ALCOHOL MIXTURES.

(Pfeiffer, 1892.)

| Composition of Homogeneous Mixture | | | Composition of Homogeneous Mixture | | |
|---|---|---|---|---|---|
| cc $HCOOC_5H_{11}$ | cc $C_2H_5OH$ | cc $H_2O$ | cc $HCOOC_5H_{11}$ | cc $C_2H_5OH$ | cc $H_2O$ |
| 3.0 | 3.0 | 1.80 | 3.0 | 33.0 | 50.71 |
| 3.0 | 9.0 | 8.77 | 3.0 | 39.0 | 65.21 |
| 3.0 | 15.0 | 17.01 | 3.0 | 45.0 | 85.10 |
| 3.0 | 21.0 | 27.06 | 3.0 | 48.0 | 94.20 |
| 3.0 | 27.0 | 38.31 | | | |

100cc $H_2O$ dissolve 0.3 gm. Iso amyl formate at 22°. (Traube, 1884; Bancroft, 1895-96.)

## BUTYL ACETATE (n) $CH_3COOC_4H_9$.

### Solubility of Butyl Acetate in Aqueous Ethyl Alcohol Mixtures.

(Pfeiffer, 1892; Bancroft, 1895.)

| Composition of Homogeneous Mixture | | | Composition of Homogeneous Mixture | | |
|---|---|---|---|---|---|
| cc $CH_3COOC_4H_9$ | cc $C_2H_5OH$ | cc $H_2O$ | cc $CH_3COOC_4H_9$ | cc. $C_2H_5OH$ | cc. $H_2O$ |
| 3.0 | 3.0 | 2.08 | 3.0 | 21.0 | 31.48 |
| 3.0 | 6.0 | 6.08 | 3.0 | 24.0 | 37.48 |
| 3.0 | 9.0 | 10.46 | 3.0 | 27.0 | 43.75 |
| 3.0 | 12.0 | 15.37 | 3.0 | 30.0 | 50.74 |
| 3.0 | 15.0 | 20.42 | 3.0 | 33.0 | 59.97 |
| 3.0 | 18.0 | 26.60 | | | |

100 gms. sat. solution of normal butyl acetate in water contain 2.3 gms. $CH_3COOC_4H_9$ at 25°.

100 gms. sat. solution of water in n butyl acetate contain 2.4 gms. $H_2O$ at 25°. (Park and Hofmann, 1932.)

## BUTYL ACETATE (*iso*) $C_2H_3O_2.C_4H_9$.

100 gms. sat. solution of iso butyl acetate in water at 20° contain 0.67 gm. $C_2H_3O_2.C_4H_9$. (Fühner, 1924.

100 cc $H_2O$ dissolve 0.7 cc iso butyl acetate at 25°. (Bancroft, 1895.

100 gms. $H_2O$ dissolve 0.5 gm. iso butyl acetate at 22°. (Traube, 1884

100 cc $H_2O$ dissolve 1.0 cc secondary Butyl acetate at about 25°. (Park and Hopkins, 1930.

## PROPYL PROPIONATE $C_2H_5COOC_3H_7$.

### Solubility of Propyl Propionate in Aqueous Ethyl Alcohol.

(Pfeiffer, 1892; Bancroft, 1895.)

| Composition of Homogeneous Mixture | | | Composition of Homogeneous Mixture | | |
|---|---|---|---|---|---|
| cc $C_2H_5COOC_3H_7$ | cc $C_2H_5OH$ | cc $H_2O$ | cc $C_2H_5COOC_3H_7$ | cc $C_2H_5OH$ | cc $H_2O$ |
| 3.0 | 3.0 | 1.58 | 3.0 | 21.0 | 27.83 |
| 3.0 | 6.0 | 4.70 | 3.0 | 24.0 | 33.75 |
| 3.0 | 9.0 | 8.35 | 3.0 | 30.0 | 47.15 |
| 3.0 | 12.0 | 12.54 | 3.0 | 36.0 | 63.18 |
| 3.0 | 15.0 | 17.15 | 3.0 | 42.0 | 83.05 |
| 3.0 | 18.0 | 22.27 | 3.0 | 48.0 | 107.46 |

100 cc $H_2O$ dissolve 0.6 cc $C_2H_5COOC_3H_7$ at 25°. (Bancroft, 1895.)

## ETHYL BUTYRATE $C_3H_7COOC_2H_5$.

### Solubility of Ethyl Butyrate in Aqueous Ethyl Alcohol at 20°.

(Bancroft, 1895.)

| Composition of Homogeneous Mixture | | | Composition of Homogeneous Mixture | | |
|---|---|---|---|---|---|
| cc $C_3H_7COOC_2H_5$ | cc $C_2H_5OH$ | cc $H_2O$ | cc $C_3H_7COOC_2H_5$ | cc $C_2H_5OH$ | cc $H_2O$ |
| 0.34 | 5.0 | 10.0 | 6.0 | 5.0 | 2.10 |
| 0.96 | 5.0 | 6.0 | 0.8 | 0.0 | 100.0 |
| 2.47 | 5.0 | 4.0 | 100.0 | 0.0 | 0.45 |
| 4.0 | 5.0 | 2.96 | | | |

100 gms. $H_2O$ dissolve 0.5 gm. $C_3H_7COOC_2H_5$ at 22°. (Traube, 1884.)

" " " " 0.62 " " " " (Fuhner, 1924.)

**CAPROIC ACID** (Hexoic Acid) $CH_3(CH_2)_4COOH$ (*normal*) and $(CH_3)_2CH(CH_2)_2COOH$ (*iso*).

100 gms. $H_2O$ dissolve 1.08 gm. Caproic acid at 20°. (Lipetz and Rimskaja 1931.)

DISTRIBUTION OF NORMAL CAPROIC ACID BETWEEN :

Water and Chloroform at 25°. (Smith, 1921-1922.)

| Millimols. per liter of $H_2O$ layer ($C_1$). | Millimols. per liter of $CHCl_3$ layer ($C_2$). | $\frac{C_2}{C_1}$. |
|---|---|---|
| 0.0843 | 0.4281 | 5.07 |
| 0.1158 | 0.6349 | 5.49 |
| 0.1875 | 1.1375 | 6.08 |
| 0.2125 | 1.4375 | 6.77 |

Water and Ether at 23°. (Behrens, 1926.)

| Concentration in $H_2O$ layer ($a$). | Concentration in $(C_2H_5)_2O$ layer ($b$). | $\frac{a}{b}$. |
|---|---|---|
| 0.00336 | 0.294 | 87.5 |
| 0.00428 | 0.380 | 88.8 |
| 0.00439 | 0.394 | 89.7 |
| 0.00545 | 0.492 | 90.3 |
| 0.00643 | 0.595 | 92.5 |
| 0.00978 | 0.967 | 98.9 |

Water and Xylene at 25°. (Smith, 1921-1922.)

| Millimols. per liter of $H_2O$ layer ($C_1$). | Millimols. per liter of $C_6H_4(CH_3)_2$ layer ($C_2$). | $\frac{C_2}{C_1}$. |
|---|---|---|
| 0.2625 | 0.5375 | 2.04 |
| 0.3375 | 0.7375 | 2.18 |
| 0.575 | 1.50 | 2.61 |
| 0.75 | 2.15 | 2.86 |
| 0.95 | 2.95 | 3.10 |
| 2.80 | 17.7 | 6.32 |

DISTRIBUTION OF HEXOIC ACID BETWEEN WATER AND BENZENE AT 25°. (Brown and Bury, 1923.)

| Normality of $CH_3(CH_2)_4COOH$ in | | | | | | | |
|---|---|---|---|---|---|---|---|
| | $H_2O$ layer. | 0.0078 | 0.0091 | 0.0102 | 0.0114 | 0.0131 | 0.0162 |
| | $C_6H_6$ layer. | 0.159 | 0.210 | 0.256 | 0.328 | 0.413 | 0.619 |

DISTRIBUTION OF ISO CAPROIC ACID AT 25° BETWEEN : (Smith 1921, 1922.)

Water and Chloroform.

| Millimols. per liter of $H_2O$ layer ($C_1$). | Millimols. per liter of $CHCl_3$ layer ($C_2$). | $\frac{C_2}{C_1}$. |
|---|---|---|
| 0.1710 | 0.755 | 4.38 |
| 0.2175 | 1.000 | 4.6 |
| 0.2900 | 1.450 | 5.0 |
| 4.475 | 2.550 | 5.7 |

Water and Xylene.

| Millimols. per liter of $H_2O$ layer ($C_1$). | Millimols. per liter of $C_6H_4(CH_3)_2$ ($C_2$). | $\frac{C_2}{C_1}$. |
|---|---|---|
| 0.4625 | 0.7500 | 1.62 |
| 0.8125 | 1.6375 | 2.02 |
| 1.325 | 3.375 | 2.54 |
| 1.85 | 5.6 | 3.02 |

DISTRIBUTION OF NORMAL CAPROIC ACID AT 25° BETWEEN: (Smith and White, 1929.)

Water and Chloroform

| Gm. Mols. $C_6H_{12}O_2$ per liter $H_2O$ layer | Gm. Mols. $C_6H_{12}O_2$ per liter $CHCl_3$ layer |
|---|---|
| 0.00102 | 0.01625 |
| 0.00138 | 0.0256 |
| 0.00171 | 0.0358 |
| 0.00222 | 0.0545 |
| 0.00308 | 0.0944 |
| 0.00398 | 0.1465 |

Water and Benzene

| Gm. Mols. $C_6H_{12}O_2$ per liter $H_2O$ layer | Gm. Mols. $C_6H_{12}O_2$ per liter $C_6H_6$ layer |
|---|---|
| 0.00219 | 0.01989 |
| 0.00247 | 0.02408 |
| 0.00263 | 0.02675 |
| 0.00360 | 0.04580 |
| 0.00388 | 0.05287 |
| 0.00568 | 0.10310 |

Water and Toluene

| Gm. Mols. $C_6H_{12}O_2$ per liter $H_2O$ layer | Gm. Mols. $C_6H_{12}O_2$ per liter $C_6H_5CH_3$ layer |
|---|---|
| 0.00236 | 0.01956 |
| 0.00263 | 0.02377 |
| 0.00281 | 0.02637 |
| 0.00385 | 0.04531 |
| 0.00412 | 0.05238 |
| 0.00494 | 0.07063 |
| 0.00607 | 0.10236 |

DISTRIBUTION OF ISO CAPROIC ACID AT 25° BETWEEN: (Smith and White, 1929.)

Water and Chloroform

| Gm. Mols. $\frac{1}{2}$ $C_6H_{12}O_2$ per liter $H_2O$ layer | Gm. Mols. $\frac{1}{2}$ $C_6H_{12}O_2$ per liter $CHCl_3$ layer |
|---|---|
| 0.00021 | 0.00148 |
| 0.00041 | 0.00358 |
| 0.00075 | 0.00813 |
| 0.00114 | 0.01530 |
| 0.00163 | 0.02708 |
| 0.00231 | 0.04718 |
| 0.00351 | 0.09298 |

Water and Benzene

| Gm. Mols. $\frac{1}{2}$ $C_6H_{12}O_2$ per liter $H_2O$ layer | Gm. Mols. $\frac{1}{2}$ $C_6H_{12}O_2$ per liter $C_6H_6$ layer |
|---|---|
| 0.00498 | 0.0589 |
| 0.00564 | 0.0742 |
| 0.00615 | 0.0874 |
| 0.00685 | 0.1030 |
| 0.00807 | 0.1420 |
| 0.00922 | 0.1800 |

## Distribution of Normal Caproic Acid at 25° Between:

(Kolossovsky and Levitas, 1935.)

### Water and Benzene

| Gm. Mols. $C_6H_{12}O_2$ per liter | | 1 |
|---|---|---|
| $H_2O$ layer(1) | $C_6H_6$ layer(2) | 2 |
| 0.01415 | 0.6917 | 0.0205 |
| 0.01493 | 0.08159 | 0.0183 |
| 0.02319 | 1.898 | 0.0122 |
| 0.03144 | 2.790 | 0.0113 |
| 0.05643 | 5.286 | 0.0107 |
| 0.09157 | 7.703 | 0.0119 |

### Water and Toluene

| Gm. Mols. $C_6H_{12}O_2$ per liter | | 1 |
|---|---|---|
| $H_2O$ layer(1) | $C_6H_5CH_3$ layer(2) | 2 |
| 0.00550 | 0.09668 | 0.0569 |
| 0.00904 | 0.2515 | 0.0359 |
| 0.01336 | 0.5345 | 0.0250 |
| 0.01753 | 0.9039 | 0.0194 |
| 0.03105 | 2.154 | 0.0144 |
| 0.05974 | 5.313 | 0.0112 |
| 0.09039 | 7.703 | 0.0117 |

## Distribution of Normal Caproic Acid at 25° Between:

(Kolossowsky and Levitas, 1935.)

### Water and Anisole

| Gm. Mols. $C_6H_{12}O_2$ per liter | | 1 |
|---|---|---|
| $H_2O$ layer(1) | $C_6H_5OCH_3$ layer (2) | 2 |
| 0.0063 | 0.1438 | 0.0438 |
| 0.0094 | 0.2476 | 0.0380 |
| 0.0126 | 0.4441 | 0.0284 |
| 0.0189 | 0.8096 | 0.0233 |
| 0.0236 | 1.2262 | 0.0192 |
| 0.0355 | 2.7314 | 0.0130 |
| 0.0910 | 7.7040 | 0.0118 |

### Water and Decalin

| Gm. Mols. $C_6H_{12}O_2$ per liter | | 1 |
|---|---|---|
| $H_2O$ layer(1) | $C_{10}H_{18}$ layer(2) | 2 |
| 0.00181 | 0.00393 | 0.472 |
| 0.00338 | 0.01572 | 0.215 |
| 0.006524 | 0.03537 | 0.184 |
| 0.01651 | 0.2083 | 0.0793 |
| 0.02279 | 0.7153 | 0.0319 |
| 0.04480 | 1.729 | 0.0259 |
| 0.06642 | 4.622 | 0.0144 |
| 0.09100 | 7.704 | 0.0118 |

### Water and Carbon Tetrachloride

| Gm. Mols. $C_6H_{12}O_2$ per liter | | 1 |
|---|---|---|
| $H_2O$ layer(2) | $CCl_4$ layer(2) | 2 |
| 0.001572 | 0.00786 | 0.200 |
| 0.003144 | 0.02948 | 0.107 |
| 0.006131 | 0.1124 | 0.0547 |
| 0.009866 | 0.2633 | 0.0375 |
| 0.01281 | 0.4677 | 0.0274 |
| 0.01886 | 0.8764 | 0.0215 |
| 0.02830 | 1.827 | 0.0155 |
| 0.0452 | 3.458 | 0.0131 |
| 0.091 | 7.704 | 0.0118 |

### Water and Methyl Iodide

| Gm. Mols. $C_6H_{12}O_2$ per liter | | 1 |
|---|---|---|
| $H_2O$ layer(1) | $CH_3I$ layer(2) | 2 |
| 0.0025 | 0.0244 | 0.1024 |
| 0.0035 | 0.0432 | 0.0810 |
| 0.0049 | 0.0770 | 0.0636 |
| 0.0077 | 0.1871 | 0.0412 |
| 0.0108 | 0.3458 | 0.0312 |
| 0.0157 | 0.6602 | 0.0238 |
| 0.0266 | 1.7135 | 0.0155 |
| 0.0377 | 2.9080 | 0.0130 |
| 0.0910 | 7.7040 | 0.0118 |

### Water and Bromo benzene

| Gm. Mols. $C_6H_{12}O_2$ per liter | | 1 |
|---|---|---|
| $H_2O$ layer(1) | $C_6H_5Br$ layer(2) | 2 |
| 0.0025 | 0.0259 | 0:0965 |
| 0.0040 | 0.0432 | 0.0929 |
| 0.0057 | 0.0825 | 0.0691 |
| 0.0105 | 0.2830 | 0.0371 |
| 0.0156 | 0.5345 | 0.0292 |
| 0.0193 | 0.8017 | 0.0241 |
| 0.0292 | 1.6404 | 0.0178 |
| 0.091 | 7.704 | 0.0118 |

### Water and Nitro benzene

| Gm. Mols. $C_6H_{12}O_2$ per liter | | 1 |
|---|---|---|
| $H_2O$ layer(1) | $C_6H_5NO_2$ layer(2) | 2 |
| 0.00220 | 0.01045 | 0.211 |
| 0.00371 | 0.03655 | 0.102 |
| 0.00582 | 0.0676 | 0.0861 |
| 0.01258 | 0.2279 | 0.0552 |
| 0.01886 | 0.4363 | 0.0432 |
| 0.02987 | 0.9982 | 0.0299 |
| 0.04559 | 2.452 | 0.0186 |
| 0.0900 | 7.700 | 0.0117 |

DISTRIBUTION OF NORMAL CAPROIC ACID BETWEEN WATER AND SEVERAL ORGANIC SOLVENTS AT 25°.

(Archibald, 1932.)

| Organic Solvent | Gm. Mols. $C_6H_{12}O_2$ per liter | | 2/1 |
|---|---|---|---|
| | $H_2O$ layer(1) | Organic Solvent layer(2) | |
| Ethyl Methyl Ketone | 0.01343 | 0.2989 | 22.26 |
| Tertiary Amyl Alcohol | 0.00355 | 0.2917 | 82.17 |
| Secondary Butyl Alcohol | 0.01165 | 0.2886 | 24.77 |
| Normal Butyl Alcohol | 0.00403 | 0.2874 | 71.32 |
| Normal Amyl Alcohol | 0.00260 | 0.2843 | 109.3 |
| Ethyl Ether | — | — | 75.0 |

## CAPROIC ACID

DISTRIBUTION OF CAPROIC ACID BETWEEN WATER AND PETROLEUM ETHER AT ROOM TEMPERATURE.

(Grossfeld and Miermeister, 1931.)

| cc 0.1 n NaOH required per 25 cc of: | | 1/2 |
|---|---|---|
| $H_2O$ layer(1) | Pet. Ether layer(2) | |
| 0.34 | 0.36 | 0.92 |
| 0.57 | 1.06 | 0.53 |
| 1.14 | 4.40 | 0.26 |
| 1.67 | 9.34 | 0.18 |
| 1.99 | 13.11 | 0.15 |

DISTRIBUTION OF CAPROIC ACID BETWEEN WATER AND OLIVE OIL.

(Bodansky and Meigs, 1932.)

| t° | Gm. Mols. $C_6H_{12}O_2$ per liter | | 1/2 |
|---|---|---|---|
| | $H_2O$ layer(1) | Oil layer(2) | |
| 25 | 0.0012 | 0.0082 | 0.146 |
| " | 0.0024 | 0.0170 | 0.141 |
| " | 0.0056 | 0.0440 | 0.127 |
| 37.5 | 0.0013 | 0.0082 | 0.159 |
| " | 0.0027 | 0.0170 | 0.159 |
| " | 0.0066 | 0.0440 | 0.165 |

Additional results for the distribution of caproic acid and of iso caproic acid between water and olive oil at 23° are given by Bodansky, 1928.)

## TRI CAPROIN $C_3H_5(CH_3(CH_2)_4COO)_3$.

Results for the reciprocal solubility of tri caproin and benzene are given by Loskit, 1928.

## PARALDEHYDE $(CH_3.CHO)_3$.

RECIPROCAL SOLUBILITY OF PARALDEHYDE AND WATER. (Pascal and Dupuy, 1920.)

Mixtures of paraldehyde and water were cooled or rewarmed while being energetically agitated and the temperature of appearance or disappearance of clouding determined to within 0°.5. At temperatures above 50° it was necessary to renew the mixture for each determination to avoid the production of a small amount of aldehyde. The paraldehyde was purified by drying and recrystallizing many times until the fusion-point became constant at 12°.4. It contained so little aldehyde that it scarcely gave a coloration with Schiff's reagent.

### Solubility of Liquid Paraldehyde in Water

(Mixtures containing an excess of $H_2O$).

| t° of clouding or clearing. | Gms. Paraldehyde per 100 gms. of solution. |
|---|---|
| 8.5..... | 13.25 |
| 11.5..... | 12.45 |
| 12.0..... | 12.60 |
| 13.5..... | 11.90 |
| 17.0..... | 11.20 |
| 27.0..... | 9.10 |
| 40.0..... | 7.65 |
| 42.5..... | 7.45 |
| 68.0..... | 6.00 |
| 75.0..... | 5.80 |
| Ice curve. | |
| —1.53..... | 9.37 |
| —1.99..... | 13.10 |
| Solid Paraldehyde Curve. | |
| 1.71 (Eutec.). | 11.8 |
| <5.0..... | 12.27 |
| 6.0..... | 12.45 |
| 9.5..... | 12.70 |

### Solubility of $H_2O$ in Paraldehyde

(Mixtures containing a large excess of Paraldehyde).

| t° of clouding or clearing. | Gms. $H_2O$ per 100 gms. of solution. |
|---|---|
| 85.0..... | 3.50 |
| 63.0..... | 2.45 |
| 46.0..... | 1.75 |
| 28.5..... | 1.30 |
| 19.0..... | 1.05 |
| 14.5..... | 0.95 |
| 10.5..... | 0.90 |
| 6.5..... | 0.80 |
| F. pt. of $H_2O$ in Paraldehyde. | |
| 9.78..... | 1.15 |
| 10.02..... | 0.88* |
| 10.28..... | 0.635 |

* The curve of the f. pt. cuts the solubility curve at 10°.02 and 0.88 % $H_2O$. This is the f. pt. of moist paraldehyde.

### SOLUBILITY OF PARALDEHYDE IN DILUTE SULFURIC ACID (5.15 % $H_2SO_4$).

| t° of clouding or clearing. | Gms. Paraldehyde per 100 gms. sol. | t° of clouding of clearing. | Gms. Paraldehyde per 100 gms. sol. |
|---|---|---|---|
| 13.0..... | 10.70 | 24.0..... | 8.45 |
| 13.5..... | 10.50 | 28.0..... | 7.95 |
| 16.0..... | 10.10 | 32.0..... | 7.50 |
| 19.5..... | 9.55 | 40.0..... | 6.95 |
| 20.0..... | 9.05 | 52.0..... | 6.15 |

### DISTRIBUTION OF ALDEHYDE BETWEEN PARALDEHYDE AND : (Pascal and Dupuy, 1920.)

| t° in each case. | Pure water. Gms. Aldehyde per liter | | Aq. 5 % $H_2SO_4$. Gms. Aldehyde per liter | | Aq. 10 % $H_2SO_4$. Gms. Aldehyde per liter | |
|---|---|---|---|---|---|---|
| | upper layer. | lower layer. | upper layer. | lower layer. | upper layer. | lower layer. |
| 12°.... | 0.62 | 2.00 | 1.87 | 5.39 | 2.31 | 6.05 |
| 12 .... | 1.10 | 3.20 | 3.45 | 8.60 | 3.55 | 9.10 |
| 12 .... | 1.95 | 5.70 | — | — | — | — |
| 20 .... | 1.15 | 3.15 | 7.70 | 12.60 | 8.30 | 11.66 |
| 20 .... | 1.20 | 3.20 | 7.90 | 14.10 | 8.35 | 12.15 |
| 20 .... | 2.30 | 5.30 | 8.03 | 13.97 | — | — |
| 40 .... | 1.43 | 2.35 | 19.90 | 19.60 | 20.02 | 12.87 |
| 40 .... | 1.70 | 2.90 | 19.91 | 19.03 | 20.02 | 15.30 |
| 40 .... | 2.90 | 4.60 | 19.91 | 19.14 | — | — |

SOLUBILITY OF PARALDEHYDE IN AQ. SALT SOLUTIONS AT ABOUT 18°.
(Traube, Schöning and Weber, 1927.)

| Aq. solution of: | Concentration | cc Paraldehyde per 5 cc salt solution |
|---|---|---|
| Water alone | — | 0.5 |
| Sodium Salicylate | saturated | 1.7 |
| Sodium benzoate | " | 0.65 |
| Aniline hydrochloride | " | 0.7 |

Freezing-point data are given by Paterno and Ampola, 1897, for mixtures of paraldehyde and ethylene bromide and for mixtures of paraldehyde and benzene.

## δ AMINOVALERIC HYDANTOIC ACID (δ Uramido valeric acid) $C_6H_{12}O_3N_2$.

| Solvent | t° | d. of sat. sol. | Gm. Mol. $C_6H_{12}O_3N_2$ per liter sat. sol. | |
|---|---|---|---|---|
| Water | 25 | 0.99763 | 0.0174 | McMeekin, Cohn |
| 100% $C_2H_5OH$ | 25 | 0.78622 | 0.00762 | and Weare, 1936. |

## CYSTINE $[SCH_2CH(NH_2)COOH]_2$, $C_6H_{12}O_4N_2S_2$.

SOLUBILITY OF LAEVO CYSTINE IN WATER.

| t° | Gms. $C_6H_{12}O_4N_2S_2$ per liter sat. sol. | Authority | t° | Gms. $C_6H_{12}O_4N_2S_2$ per liter sat. sol. | Authority |
|---|---|---|---|---|---|
| 16-18 | 0.109 | (Blix, 1928.) | 25 | 0.115. | (Sano, 1926.) |
| 19 | 0.113 | (Neuberg, 1905.) | 25 | 0.109 | (McMeekin, Cohn and Blanchard, 1937.) |
| 20 | 0.168 | (Pfeiffer and Angern, 1924.) | 25 | 0.1095 | (Dalton and Schmidt, 1935.) |
| 20 | 0.190 | (Hoffman and Gortner, 1922.) | 25 | 0.108-0.113 | (Loring and du Vigneaud, 1934.) |
| 24-27.5 | 0.133 | (Toennies and Lavine, 1930.) | 25 | 0.1097 | (Takahashi and Yaginuma, 1929.) |

The solubility of other isomers of Cystine was studied by Andrews and de Beer 1928, and by Lor ing and du Vigneaud, 1934. The former obtained results which suggested that d cystine may be about 4 times as soluble as 1 cystine. The subsequent results of Loring and du Vigeaud showed however, that these two isomers have identical solubilities. They also found that a mixture of d and 1 cystine in contact with water is transformed slowly into dl cystine. A mixture of 0.020 gm. of 1 + 0.020 gm. of d cystine + 100 cc of $H_2O$, rotated constantly at 25°, was found to contain the following amounts of cystine after successive intervals of time.

| Time | Gms. Cystine per liter |
|---|---|
| After 15 minutes | 0.202 |
| " 10 hours | 0.215 |
| " 180 " | 0.057 |

The solid phase after 180 hours, as shown by microscopic examination, consisted of dl crystals. The solubility of meso cystine was found to be 0.056 gm. per liter. The solubility of mixtures of the two inactive isomers and of mixtures of the active and inactive isomers was found to be approximately the summation of the individual solubilities of each isomer.

$C_6H_{12}O_4$

### Solubility of *l* Cystine in Water.

(Dalton and Schmidt, 1935.)

The following values were derived from a solubility equation calculated from 20 very careful determinations at 9 different temperatures between 0° and 65°. The sample of cystine was prepared from a cystine stone taking care that the preparation should not be in contact with acid any longer than absolutely necessary and crystallizing twice from hot water. Determinations made with 0.01 gm. and with 0.10 gm. of sample per 60 cc of water gave results which agreed within 3 percent hence only insignificant amounts of inactive isomers were present.

| t° | Gms. *l* Cystine per 1000gms. $H_2O$ | t° | Gms. *l* Cystine per 1000 gms. $H_2O$ | t° | Gms. *l* cystine per 1000 gms. $H_2O$ |
|---|---|---|---|---|---|
| 0.0 | 0.0502 | 30 | 0.1281 | 55 | 0.2799 |
| 5 | 0.0587 | 35 | 0.1498 | 60 | 0.3272 |
| 10 | 0.0686 | 40 | 0.1751 | 65 | 0.3826 |
| 15 | 0.0802 | 45 | 0.2048 | 70 | 0.4472 |
| 20 | 0.0938 | 50 | 0.2394 | 75 | 0.5229 |
| 25 | 0.1096 | | | 100 | 1.142 |

## CYSTINE

### Solubility of *l* Cystine in Aqueous Salt Solutions at 16-18°

(Blix, 1928.)

The experiments were made by adding 0.15 -0.20 gm. *l* cystine to 15-20 cc of 0.1 n NaOH and then the amount of salt to yield the desired final concentration, next enough 0.1 n $CH_3COOH$ to bring the $p_H$ to 5.6 (the mean of urine $p_H$) and finally enough $H_2O$ to bring the volume to 300 cc. A drop of $CHCl_3$ was added to prevent growth of bacteria. The mixtures were shaken constantly for 5 hours daily for 5 days. The cystine in the saturated solutions was calculated from determinations of sulfur made by oxidizing with alkaline permanganate and precipitating with $BaCl_2$.

| Salt and conc. in normality | | Gms. Cystine per liter sat. sol. | Salt and conc. in normality | | Gms. Cystine per liter sat. sol. |
|---|---|---|---|---|---|
| KCl | 0.25n | 0.133 | $NaH_2PO_4$ + $Na_2HPO_4$ | 0.25 | 0.166 |
| NaCl | " | 0.138 | $CaCl_2$ | 0.0625 | 0.128 |
| $NH_4Cl$ | " | 0.121 | " | 0.125 | 0.144 |
| $MgCl_2$ | " | 0.155 | " | 0.25 | 0.173 |
| $Na_2SO_4$ | " | 0.129 | " | 0.50 | 0.215 |
| $K_2SO_4$ | " | 0.126 | " | 1.00 | 0.274 |
| $KH_2PO_4$ + $K_2HPO_4$ | " | 0.133 | | | |

The influence of the diffusible organic substances and of the colloids of urine upon the solubility of cystine was also studied. The solubility of cystine in urine is greater than corresponds to the increase produced by the combinations studied.

## Solubility of Cystine in Aqueous Alcohol Solutions of Sodium Chloride and of Calcium Chloride at 25°.

(McMeekin, Cohn, and Blanchard, 1937.)

Results for Aq. 15% $C_2H_5OH$ Solutions of NaCl

| Conc. of NaCl in solvent | | d. of sat. sol. | Gm. Mols. $C_6H_{12}O_4N_2S_2$ per liter sat. sol. |
|---|---|---|---|
| Mols. | Ionic | | |
| 0.0 | 0.0 | 0.97764 | 0.000161 |
| 0.025 | 0.05 | 0.97972 | 0.000169 |
| 0.05 | 0.10 | 0.98183 | 0.000178 |
| 0.125 | 0.25 | 0.98777 | 0.000197 |
| 0.25 | 0.50 | 0.99791 | 0.000220 |

Results for Aq. 30% $C_2H_5OH$ Solutions of NaCl

| Conc. of NaCl in solvent | | d. of sat. sol. | Gm. Mols. $C_6H_{12}O_4N_2S_2$ per liter sat. sol. |
|---|---|---|---|
| Mols. | Ionic | | |
| 0.0 | 0.0 | 0.95980 | 0.0000507 |
| 0.025 | 0.05 | 0.96223 | 0.0000544 |
| 0.05 | 0.10 | 0.96388 | 0.0000582 |
| 0.125 | 0.25 | 0.97046 | 0.0000685 |
| 0.25 | 0.50 | 0.97937 | 0.0000866 |

Results for Aq. 30% $C_2H_5OH$ Solutions of $CaCl_2$

| Conc. of $CaCl_2$ in solvent | | d. of sat. sol. | Gm. Mols. $C_6H_{12}O_4N_2S_2$ per liter sat. sol. |
|---|---|---|---|
| Mols. | Ionic | | |
| 0.025 | 0.05 | 0.96124 | 0.0000550 |
| 0.05 | 0.10 | 0.96267 | 0.0000597 |
| 0.075 | 0.15 | 0.96418 | 0.0000649 |
| 0.15 | 0.30 | 0.96857 | 0.0000801 |
| 0.25 | 0.75 | 0.98155 | 0.000128 |

Experiments showing the influence of pH and of several salts upon the solubility of cystine in water are given by Okabe, 1928. Constant agitation was not employed for reaching equilibrium. The prepared mixtures were cooled to 0° and the excess of dissolved cystine was caused to crystallize out by stirring now and then during one hour. A minimum solubility of about 0.05 gm. cystine per liter in 0.046 mol. NaCl and $NH_4Cl$ solutions was found at pH 6.0. NaCl, $(NH_4)_2SO_4$ and $Na_2SO_4$ increase the solubility of cystine, $NH_4Cl$ and $CH_3COONH_4$ have no effect and $C_2H_5OH$ decreased its solubility in water.

## Solubility of *l* Cystine in Aqueous Salt Solutions at 25°.

(McMeekin, Cohn and Blanchard, 1937.)

Results for aq. solutions of:

### Sodium Chloride

| Concentration of aq. salt solution | | d. of sat. sol. | Gm. Mols. $C_6H_{12}O_4N_2S_2$ per liter |
|---|---|---|---|
| Mols. | Ionic | | |
| 0.0 | 0.0 | 0.9972 | 0.000454 |
| 0.025 | 0.05 | 0.9993 | 0.000478 |
| 0.05 | 0.10 | 1.0014 | 0.000494 |
| 0.10 | 0.20 | 1.0054 | 0.000522 |
| 0.25 | 0.50 | 1.0176 | 0.000578 |
| 0.50 | 1.00 | 1.0372 | 0.000650 |
| 2.00 | 4.00 | 1.475 | 0.000845 |

### Calcium Chloride

| Concentration of aq. salt solution | | d. of sat. sol. | Gm. Mols. $C_6H_{12}O_4N_2S_2$ per liter |
|---|---|---|---|
| Mols. | Ionic | | |
| 0.0625 | 0.188 | 1.0030 | 0.000532 |
| 0.10 | 0.30 | 1.00627 | 0.000580 |
| 0.125 | 0.375 | 1.0083 | 0.000599 |
| 0.15 | 0.45 | 1.01083 | 0.000633 |
| 0.25 | 0.75 | 1.0195 | 0.000720 |
| 0.50 | 1.50 | 1.0421 | 0.000895 |
| 1.00 | 3.00 | 1.0840 | 0.001140 |

### Sodium Sulfate

| | | | |
|---|---|---|---|
| 0.10 | 0.30 | 1.0091 | 0.000533 |
| 0.25 | 0.75 | 1.0280 | 0.000579 |
| 0.50 | 1.50 | 1.0587 | 0.000616 |
| 1.00 | 3.00 | 1.1157 | 0.000645 |
| 1.10 | 3.30 | 1.1273 | 0.000649 |
| 1.25 | 3.75 | 1.1441 | 0.000621 |
| 1.41 | 4.23 | 1.1632 | 0.000612 |
| 1.50 | 4.50 | 1.1652 | 0.000595 |

### Ammonium Sulfate

| | | | |
|---|---|---|---|
| 0.10 | 0.30 | 1.0047 | 0.000529 |
| 0.25 | 0.75 | 1.0164 | 0.000591 |
| 0.50 | 1.50 | 1.0345 | 0.000666 |
| 1.00 | 3.00 | 1.0690 | 0.000720 |
| 1.50 | 4.50 | 1.1015 | 0.000699 |
| 2.00 | 6.00 | 1.1322 | 0.000662 |
| 2.50 | 7.50 | 1.1618 | 0.000579 |
| 2.63 | 7.89 | 1.1670 | 0.000545 |
| 3.00 | 9.00 | 1.1901 | 0.000475 |
| 3.50 | 10.50 | 1.2145 | 0.000416 |
| 4.00 | 12.00 | 1.2409 | 0.000316 |

**GLUCOSE** *d* $C_6H_{12}O_6.H_2O$.

| | | | | | | |
|---|---|---|---|---|---|---|
| 100 gms. $H_2O$ | dissolve 82 | gms. glucose at 20–25°. | (Dehn, 1917.) |
| 100 gms. pyridine | " 7.62 | " " | " | " |
| 100 gms. aq. 50% pyridine | " 49.17 | " " | " | " |
| 100 gms. trichlor ethylene | " 0.006 | " " | 15° | |

(Wester and Bruins, 1914.)

**GLUCOSE** (Dextrose) $C_6H_{12}O_2.H_2O$.

Solubility of Glucose in Water. (Jackson and Silsbee, 1922.)

Saturation was obtained by constant agitation in a thermostat. The saturated solutions were analyzed by a densimetric and polariscopic determination of the dextrose in the sample.

| t°. | Gms. $C_6H_{12}O_6$ per 100 gms. sat. sol. | Solid Phase. |
|---|---|---|
| —0.772..... | 6.83 | Ice |
| —2.116..... | 16.65 | » |
| —2.305..... | 17.59 | » |
| —5.605..... | 33.02 | » |
| —5.3 (Eutec.). | 31.75 | »+$C_6H_{12}O_6.H_2O$ |
| +0.5..... | 35.2 | $\alpha C_6H_{12}O_6.H_2O$ |
| 15.0..... | 44.96 | » |
| 22.98..... | 49.37 | » |
| 28.07..... | 52.99 | » |
| 30.0..... | 54.64 | » |
| 35.0..... | 58.02 | » |
| 40.4..... | 62.13 | » |
| 41.45..... | 62.82 | $\alpha C_6H_{12}O_6.H_2O$ |
| 45.0..... | 65.71 | » |
| 50.0 (tr. pt.).. | 70.90 | »+$\alpha C_6H_{12}O_6$ |
| 28.0..... | 67.0 (unstable) | $\alpha C_6H_{12}O_6$ |
| 40.0..... | 67.6 » | » |
| 45.0..... | 69.69 » | » |
| 55.22..... | 73.08 (stable) | » |
| 64.75..... | 76.36 » | » |
| 70.2..... | 78.23 » | » |
| 80.5..... | 81.49 » | » |
| 90.8..... | 84.90 » | » |

A recalculation and discussion of the above results is given by Gillis, 1923.

## Solubility of Glucose in Methyl Alcohol.

(Gillis and Nachtergaele, 1934.)

At temperatures below 50° the saturated solutions obtained by constant agitation were analyzed by evaporation and weighing the residue and also by polarametric analysis. Above 50° the point of disappearance of the last crystal in known mixtures was determined.

| t° | Gms. $C_6H_{12}O_6$ per 100 gms. sat. sol. | Gms. $C_6H_{12}O_6$ per 100 gms. $CH_3OH$ | Solid Phase |
|---|---|---|---|
| 0.0 | 1.5 | 1.52 | $\alpha\ C_6H_{12}O_6$ |
| 25.0 | 2.3 | 2.35 | " |
| 35.0 | 3.4 | 3.51 | " |
| 50.0 | 4.9 | 5.15 | " |
| 76.1 | 9.96 | 11.06 | " |
| 87.5 | 15.3 | 18.06 | " |
| 98.0 | 24.43 | 32.32 | " |
| 99.5 | 27.6 | 38.1 | " |
| 104.2 | 40.0 | 66.66 | " |
| 105.0 | 49.5 | 98.00 | $\alpha\ C_6H_{12}O_6$ |
| 106.6 | 54.6 | 120.26 | |
| 108.6 tr.pt | 64.8 | 184.10 | " $+\beta\ C_6H_{12}O_6$ |
| 113 | 69.8 | 231.12 | $\beta\ C_6H_{12}O_6$ |
| 117.2 | 74.9 | 298.40 | " |
| 119.2 | 78.3 | 360.82 | " |
| 122.8 | 83.2 | 495.23 | " |
| 125.9 | 87.2 | 681.25 | " |
| 128.5 | 92.0 | 1150.00 | " |

## Solubility of Several Sugars in Aqueous Alcohol at 20°.

(Hudson and Yanovsky, 1917.)

| Sugar. | Formula. | Solvent. | Gms. Anhydrous Sugar per 100 cc. Solution. Initial Solubility. | Final Solubility. |
|---|---|---|---|---|
| $\alpha$ Arabinose | $C_5H_{10}O_5$ | 80% $C_2H_5OH$ | 0.74 | 1.94 |
| $\beta$ Cellose | $C_{12}H_{22}O_{11}$ | 20% " | 3.2 | 4.7 |
| $\beta$ Fructose | $C_6H_{12}O_6$ | 80% " | 13.4 | 27.4 |
| $\beta$ " | " | 95% " | 1.8 | 4.2 |
| $\beta$ " | " | Methyl Alcohol | 5.2 | 11.1 |
| $\alpha$ Galactose | $C_6H_{12}O_6$ | 60% $C_2H_5OH$ | 1.1 | 3.1 |
| $\alpha$ " | " | 80% " | 0.27 | 0.65 |
| $\beta, \alpha$ Glucoheptose | $C_7H_{14}O_7$ | 20% " | 4 | 4.5 |
| $\alpha$ Glucose | $C_6H_{12}O_6$ | 80% " | 2 | 4.5 |
| $\alpha$ " | " | Methyl Alcohol | 0.85 | 1.6 |
| $\alpha$ " hydrate | $C_6H_{12}O_6.H_2O$ | 80% $C_2H_5OH$ | 1.3 | 3 |
| $\beta$ Glucose | $C_6H_{12}O_6$. | 80% " | 4.9 | 9.1 |
| $\alpha$ Lactose hydrate | $C_{12}H_{22}O_{11}.H_2O$ | 40% " | 1.1 | 2.4 |
| $\alpha$ Lyxose | $C_5H_{11}O_5$ | 90% " | 5.4 | 7.9 |
| $\beta$ Maltose hydrate | $C_{12}H_{22}O_{11}.H_2O$ | 60% " | 3 | 4.75 |
| $\beta$ Mannose | $C_6H_{12}O_6$ | 80% " | 2.4 | 13 |
| $\beta$ " | " | Methyl Alcohol | 0.78 | 4.4 |
| $\beta$ Mellibose Dihydrate | $C_{12}H_{22}O_4.2H_2O$ | 80% $C_2H_5OH$ | 0.76 | 1.3 |
| $\alpha$ Rhamnose Hydrate | $C_6H_{12}O_5.H_2O$ | 100% " | 8.6 | 9.5 |
| $\alpha$ " " | " | 70% " | 8.2 | 9.6 |
| $\alpha$ Xylose | $C_5H_{10}O_5$ | 80% " | 2.7 | 6.2 |
| Sucrose | $C_{12}H_{22}O_{11}$ | 80% " | 3.7 | 3.7 |
| Trehalose Dihydrate | $C_{12}H_{22}O_{11}.2H_2O$ | 70% " | 1.8 | 1.8 |
| Raffinose Pentahydrate | $C_{18}H_{32}O_{16}.5H_2O$ | 50% " | 1.4 | 1.4 |

## Solubility of Glucose in Several Solvents at 23°.

(Parks, Huffman and Cattoir, 1928.)

| Solvent | Gms. per 100 gms. sat. solution: Vitreous glucose | Crystalline glucose |
|---|---|---|
| Ethyl alcohol 99% | 4.70 | 0.44 |
| " " 100% | 1.58 | 0.22 |
| i Propyl alcohol | 1.07 | 0.08 |
| Acetone | 0.184 | 0.014 |

## Solubility of Sorbose and Gulose in Water and Alcohols.

(de Bruyn and van Ekenstein, 1900.)

| Sugar. | M.-pt. | Gms. Sugar per 100 cc. Sat. Sol. in: | | |
|---|---|---|---|---|
| | | $H_2O$ at 100°. | $CH_3OH$ at 17°. | $C_2H_5OH$ at 17°. |
| *d* Sorbose | 151 | 0.22 | 1.70 | 1.02 |
| *l* Sorbose | 150 | 0.23 | 1.68 | 1 |
| *l* Gulose | 150 | 0.24 | 1.72 | 1.04 |

100 gms. $H_2O$ dissolve 108 gms. maltose at 20°–25°. (Dehn, 1917.)
100 gms. $H_2O$ dissolve 14.3 gms. raffinose at 20°–25°. "

## Solubility of Phenylhydrazones and β Naphthylhydrazones of the Sugars in Water and in Alcohols at 16°–18°.

(van Ekenstein and de Bruyn, 1896.)

The hydrazones were prepared by adding to a concentrated and warm solution of the sugar the equivalent quantity of the hydrazine dissolved in the molecular quantity of glacial acetic acid. The precipitated hydrazones were recrystallized from 30 to 50 per cent alcohol. No details in regard to the method of obtaining saturation or of analysis of the solutions are given.

| Phenylhydrazone of: | M.-pt. | Gms. Compound per 100 cc. Sat. Sol. in: | | |
|---|---|---|---|---|
| | | Water. | $CH_3OH$. | $C_2H_5OH$. |
| Methyl Mannose | 178 | 0.2–0.06 | 0.59 | 0.05–0.02 |
| " Arabinose | 161 | " | ... | " |
| " Rhamnose | 124 | " | very sl. sol. | " |
| " Galactose | 180 | " | " | " |
| Ethyl Galactose | 169 | ... | ... | 0.1 |
| " Mannose | 159 | ... | ... | 0.2 |
| " Arabinose | 153 | ... | ... | 0.4 |
| " Rhamnose | 123 | ... | very sl. sol. | ... |
| Amyl Galactose | 116 | ... | ... | 0.6 |
| " Mannose | 134 | ... | ... | 3.5 |
| " Arabinose | 120 | ... | ... | 3.6 |
| " Rhamnose | 99 | ... | very sl. sol. | 6.5 |
| " Glucose | 128 | ... | ... | 1.2 |
| " Lactose | 123 | ... | ... | 0.4 |
| Allyl Galactose | 157 | ... | ... | 0.3 |
| " Mannose | 142 | ... | ... | 0.7 |
| " Arabinose | 145 | ... | ... | 0.5 |
| " Rhamnose | 135 | ... | ... | ... |
| " Glucose | 155 | ... | ... | ... |
| " Lactose | 132 | ... | ... | 0.2 |
| " Melibose | 192 | ... | ... | 0.3 |
| Benzyl Galactose | 154 | ... | 0.9 | 0.08 |
| " Mannose | 165 | ... | 0.55 | 0.2 |
| " Arabinose | 170 | ... | 0.4 | 0.06 |
| " Rhamnose | 121 | ... | 15.4 | 6.7 |
| " Glucose | 150 | ... | 0.5 | 0.10 |
| " Lactose | 128 | ... | 0.9 | 0.06 |
| β Naphthyl Galactose | 167 | 0.14 | ... | 0.24* |
| " Mannose | 157 | 0.18 | ... | 0.25* |
| " Arabinose | 141 | 0.22 | ... | 0.62* |
| " Rhamnose | 170 | 0.20 | ... | 0.44* |
| " Glucose | 95 | 0.25 | ... | 5* |
| " Xylose | 70 | 0.32 | ... | 6.62* |
| " Lactose | 203 | 0.07 | ... | 0.2* |
| " Maltose | 176 | ... | ... | 0.4* |
| " Melibose | 135 | ... | ... | 1.3* |

* Solvent 96 per cent $C_2H_5OH$.

**GALACTOSE** $C_6H_{12}O_6$.

100 gms. saturated solution in pyridine contain 5.45 gms. $C_6H_{12}O_6$ at 26°, density of solution = 1.0065. (Holty, 1905.)

100 gms. $H_2O$ dissolve 68.3 gms. galactose at 20–25°. (Dehn, 917.)

100 gms. aq. 50% pyridine dissolve 6.83 gms. galactose at 20–25°. "

Iso**INOSITOL** $C_6H_{12}O_6$.

100 gms. $H_2O$ dissolve 25.12 gms. $C_6H_{12}O_2$ at 18° and 43.22 gms. at 100°. (Müller, 1912.)

**RHAMNOSE**-l-$CH_3(CHOH)_4CHO + H_2O$.

SOLUBILITY OF RHAMNOSE IN SEVERAL ALCOHOLS.

(Upson, Fluevog and Albert, 1935.)

The determinations were made by observing the temperatures at which the last crystal disappeared from mixtures of known amounts of solid and solvent contained in 3 to 15 cc sealed glass bulbs while being slowly heated.

Results for the solubility in:

| Methyl alcohol | | Ethyl alcohol | | n Propyl alcohol | |
|---|---|---|---|---|---|
| t° | Gm. Mols. $C_6H_{12}O_5 \cdot H_2O$ per 100 gm. mols. $CH_3OH$ | t° | Gm. Mols. $C_6H_{12}O_5 \cdot H_2O$ per 100 gm. mols. $C_2H_5OH$ | t° | Gm. Mols. $C_6H_{12}O_5 \cdot H_2O$ per 100 gm. mols. $C_3H_7OH$ |
| 35.9 | 16.7 | 42.0 | 7.93 | 31.0 | 2.43 |
| 42.6 | 24.4 | 49.3 | 12.6 | 40.0 | 3.32 |
| 49.1 | 35.5 | 53.6 | 17.2 | 46.1 | 4.43 |
| 53.3 | 44.4 | 56.1 | 21.5 | 51.2 | 6.04 |
| 56.0 | 49.9 | 59.2 | 26.1 | 56.5 | 8.04 |
| 60.5 | 61.4 | 61.1 | 30.7 | 61.1 | 10.33 |
| | | | | 63.2 | 12.44 |

| Iso propyl alcohol | | n Butyl alcohol | | Iso Butyl alcohol | |
|---|---|---|---|---|---|
| t° | Gm. Mols. $C_6H_{12}O_5 \cdot H_2O$ per 100 gm. mols. $C_3H_7OH$ | t° | Gm. Mols. $C_6H_{12}O_5 \cdot H_2O$ per 100 gm. mols. $C_4H_9OH$ | t° | Gm. Mols. $C_6H_{12}O_5 \cdot H_2O$ per 100 gm. mols. $C_4H_9OH$ |
| 36.8 | 3.01 | 32.3 | 1.85 | 40.4 | 2.18 |
| 44.5 | 4.06 | 40.9 | 2.27 | 44.8 | 2.85 |
| 49.3 | 5.37 | 47.6 | 3.38 | 51.4 | 3.78 |
| 53.8 | 6.86 | 53.6 | 4.39 | 55.0 | 4.51 |
| 55.3 | 7.49 | 55.2 | 4.89 | 61.2 | 6.17 |
| 61.2 | 10.70 | 61.0 | 6.66 | 66.6 | 7.83 |

| Secondary Butyl alcohol | | Tertiary Butyl alcohol | | Allyl alcohol | |
|---|---|---|---|---|---|
| t° | Gm. Mols. $C_6H_{12}O_5 \cdot H_2O$ per 100 gm. mols. $C_4H_9OH$ | t° | Gm. Mols. $C_6H_{12}O_5 \cdot H_2O$ per 100 gm. mols. $C_4H_9OH$ | t° | Gm. Mols. $C_6H_{12}O_5 \cdot H_2O$ per 100 gm. mols. $C_3H_5OH$ |
| 43.1 | 3.25 | 42.4 | 3.97 | 35.8 | 4.05 |
| 49.1 | 4.04 | 53.2 | 5.99 | 46.1 | 6.28 |
| 52.5 | 4.68 | 57.1 | 7.10 | 54.5 | 10.72 |
| 58.6 | 6.41 | 62.3 | 8.72 | 60.5 | 15.62 |
| 65.4 | 8.74 | 67.4 | 11.40 | 62.4 | 18.60 |
| 72.4 | 13.86 | | | | |

$C_6H_{12}O_6$

**MANNOSE** α-d and β-d, $CH_2OH(CHOH)_4CHO$.

## Solubility of Each Separately in Several Alcohols.

(Upson, Fluevog and Albert, 1935.)

Results for the Solubility in:

### Methyl Alcohol

| α-d-Mannose | | β-d-Mannose | |
|---|---|---|---|
| t° | Gm. Mol. $C_6H_{12}O_6$ per 100 gm. mol. Alcohol | t° | Gm. Mol. $C_6H_{12}O_6$ per 100 gm. mol. Alcohol |
| 44.8 | 2.18 | 41.5 | 1.84 |
| 46.1 | 2.29 | 45.0 | 2.19 |
| 50.2 | 2.84 | 51.3 | 2.82 |
| 53.9 | 3.38 | 55.0 | 3.26 |
| 58.9 | 4.22 | 59.1 | 3.95 |
| 62.6 | 5.07 | 64.2 | 4.97 |

### Ethyl Alcohol

| α-d-Mannose | | β-d-Mannose | |
|---|---|---|---|
| t° | Gm. Mol. $C_6H_{12}O_6$ per 100 gm. mol. Alcohol | t° | Gm. Mol. $C_6H_{12}O_6$ per 100 gm. mol. Alcohol |
| 43.3 | 0.353 | 48.2 | 0.337 |
| 52.0 | 0.490 | 51.8 | 0.394 |
| 57.9 | 0.627 | 55.3 | 0.455 |
| 58.3 | 0.639 | 61.2 | 0.568 |
| 61.1 | 0.695 | 65.4 | 0.697 |
| 67.6 | 0.895 | 71.4 | 0.867 |

### Normal Propyl Alcohol

| | | | |
|---|---|---|---|
| 41.3 | 0.129 | 48.7 | 0.123 |
| 47.1 | 0.164 | 53.0 | 0.149 |
| 56.4 | 0.248 | 59.8 | 0.192 |
| 60.0 | 0.290 | 65.6 | 0.250 |
| 63.1 | 0.320 | 70.3 | 0.306 |
| 68.4 | 0.396 | 75.7 | 0.419 |

### Iso Propyl Alcohol

| | | | |
|---|---|---|---|
| 40.2 | 0.131 | 47.1 | 0.130 |
| 49.3 | 0.191 | 51.7 | 0.159 |
| 52.3 | 0.227 | 58.3 | 0.206 |
| 57.7 | 0.297 | 62.4 | 0.250 |
| 59.3 | 0.321 | 67.6 | 0.312 |
| 64.2 | 0.388 | 71.1 | 0.371 |

### Normal Butyl Alcohol

| | | | |
|---|---|---|---|
| 42.9 | 0.0888 | 41.3 | 0.0679 |
| 47.1 | 0.101 | 51.2 | 0.0815 |
| 51.0 | 0.116 | 55.8 | 0.101 |
| 55.8 | 0.142 | 60.1 | 0.127 |
| 62.9 | 0.199 | 65.1 | 0.165 |
| 69.6 | 0.281 | 72.6 | 0.249 |

### Iso Butyl Alcohol

| | | | |
|---|---|---|---|
| 47.1 | 0.0848 | 47.0 | 0.0608 |
| 52.1 | 0.106 | 49.8 | 0.0679 |
| 55.1 | 0.118 | 54.0 | 0.0820 |
| 57.6 | 0.135 | 58.2 | 0.103 |
| 62.6 | 0.180 | 63.8 | 0.137 |
| 72.5 | 0.269 | 72.1 | 0.203 |

### Secondary Butyl Alcohol

| | | | |
|---|---|---|---|
| 46.1 | 0.132 | 45.1 | 0.0933 |
| 50.8 | 0.162 | 48.7 | 0.116 |
| 55.4 | 0.199 | 53.9 | 0.144 |
| 56.4 | 0.209 | 58.0 | 0.175 |
| 66.0 | 0.281 | 65.2 | 0.239 |
| 76.1 | 0.438 | 70.6 | 0.301 |

### Tertiary Butyl Alcohol

| | | | |
|---|---|---|---|
| 45.3 | 0.208 | 47.9 | 0.204 |
| 47.3 | 0.227 | 52.3 | 0.246 |
| 52.8 | 0.272 | 58.1 | 0.318 |
| 54.2 | 0.308 | 65.0 | 0.411 |
| 64.2 | 0.447 | 69.5 | 0.487 |
| 68.7 | 0.521 | 74.0 | 0.589 |

### Allyl Alcohol

| | | | |
|---|---|---|---|
| 48.2 | 0.323 | 47.2 | 0.235 |
| 52.0 | 0.378 | 51.8 | 0.281 |
| 55.3 | 0.438 | 58.4 | 0.392 |
| 56.5 | 0.455 | 65.0 | 0.511 |
| 66.6 | 0.672 | 68.2 | 0.586 |

d MANNONIC γ-LACTONE M. pt. 152 $[\alpha]_D^{20^\circ} = +52.3^\circ$.

d MANNONIC δ-LACTONE M. pt. 162.5 $[\alpha]_D^{20^\circ} = +112^\circ$.

## Solubility of Each Separately in Several Alcohols.

(Upson, Fluevog and Albert, 1935.)

Results for the solubility in:

### Methyl Alcohol

| t° | Gm. Mols. γ Lactone per 100 gm. mols. Alcohol | t° | Gm. Mols. δ Lactone per 100 gm. mols. Alcohol |
|---|---|---|---|
| 40.0 | 0.813 | 35.8 | 0.235 |
| 47.9 | 1.083 | 45.3 | 0.341 |
| 53.4 | 1.325 | 54.9 | 0.508 |
| 60.9 | 1.797 | 63.4 | 0.779 |
| 67.4 | 2.367 | 66.9 | 0.957 |

### Ethyl Alcohol

| t° | Gm. Mols. γ Lactone per 100 gm. mols. Alcohol | t° | Gm. Mols. δ Lactone per 100 gm. mols. Alcohol |
|---|---|---|---|
| 44.1 | 0.207 | 42.0 | 0.0853 |
| 48.3 | 0.250 | 49.8 | 0.124 |
| 55.9 | 0.357 | 53.6 | 0.144 |
| 60.4 | 0.427 | 60.4 | 0.192 |
| 64.5 | 0.519 | 68.2 | 0.279 |

### Normal Propyl Alcohol

| | | | |
|---|---|---|---|
| 42.2 | 0.0849 | 45.9 | 0.0476 |
| 47.3 | 0.105 | 53.9 | 0.0679 |
| 55.3 | 0.158 | 65.4 | 0.123 |
| 64.6 | 0.244 | 65.4 | 0.123 |
| 68.6 | 0.296 | 71.4 | 0.157 |

### Iso Propyl Alcohol

| | | | |
|---|---|---|---|
| 43.8 | 0.109 | 45.6 | 0.0607 |
| 51.6 | 0.163 | 55.4 | 0.0935 |
| 57.4 | 0.215 | 61.1 | 0.121 |
| 64.4 | 0.294 | 65.3 | 0.146 |
| 67.9 | 0.349 | 69.7 | 0.181 |

### Normal Butyl Alcohol

| | | | |
|---|---|---|---|
| 47.1 | 0.0719 | 48.1 | 0.0379 |
| 51.3 | 0.0868 | 50.8 | 0.0414 |
| 54.7 | 0.106 | 53.9 | 0.0472 |
| 60.1 | 0.139 | 59.6 | 0.0634 |
| 63.0 | 0.163 | 65.0 | 0.0822 |
| 71.5 | 0.242 | 69.4 | 0.103 |

### Iso Butyl Alcohol

| | | | |
|---|---|---|---|
| 49.5 | 0.0659 | 46.8 | 0.0307 |
| 51.7 | 0.0770 | 52.3 | 0.0402 |
| 56.9 | 0.102 | 55.4 | 0.0461 |
| 63.3 | 0.142 | 59.5 | 0.0582 |
| 66.4 | 0.164 | 63.0 | 0.0693 |
| 75.1 | 0.236 | 68.1 | 0.0842 |

### Secondary Butyl Alcohol

| | | | |
|---|---|---|---|
| 43.1 | 0.0807 | 44.9 | 0.0415 |
| 46.6 | 0.0927 | 49.2 | 0.0487 |
| 52.0 | 0.125 | 52.0 | 0.0637 |
| 57.4 | 0.167 | 58.5 | 0.0827 |
| 64.7 | 0.238 | 64.9 | 0.115 |
| 68.7 | 0.286 | 71.9 | 0.152 |

### Tertiary Butyl Alcohol

| | | | |
|---|---|---|---|
| 35.2 | 0.0938 | 39.4 | 0.0638 |
| 41.9 | 0.123 | 43.4 | 0.0752 |
| 48.7 | 0.173 | 47.6 | 0.0907 |
| 55.6 | 0.250 | 53.7 | 0.125 |
| 59.0 | 0.288 | 57.7 | 0.153 |
| 70.0 | 0.424 | 67.1 | 0.226 |

### Allyl Alcohol

| | | | |
|---|---|---|---|
| 46.4 | 0.215 | 42.0 | 0.0806 |
| 49.7 | 0.250 | 46.6 | 0.0964 |
| 55.1 | 0.320 | 53.0 | 0.127 |
| 60.4 | 0.404 | 57.7 | 0.156 |
| 63.4 | 0.464 | 62.0 | 0.192 |
| | | 67.6 | 0.247 |

α **METHYL-d-MANNOSIDE** M. pt. 195°, $[\alpha]_D^{20^\circ} = +24.5^\circ$.

Results for the solubility in:

| Methyl Alcohol | | Ethyl Alcohol | | Propyl Alcohol | |
|---|---|---|---|---|---|
| t° | Gm. Mols. Mannoside in 100 gm. Mols. $CH_3OH$ | t° | Gm. Mols. Mannoside in 100 gm. mols. $C_2H_5OH$ | t° | Gm. Mols. Mannoside in 100 gm. mols. $C_3H_7OH$ |
| 40.2 | 0.458 | 37.9 | 0.0940 | 45.8 | 0.077 |
| 43.7 | 0.523 | 47.4 | 0.177 | 48.9 | 0.099 |
| 49.8 | 0.652 | 54.6 | 0.249 | 54.6 | 0.148 |
| 54.9 | 0.776 | 62.0 | 0.342 | 60.1 | 0.194 |
| 58.4 | 0.867 | 66.1 | 0.413 | 68.1 | 0.270 |
| 62.4 | 1.010 | 76.2 | 0.615 | 75.3 | 0.386 |
| 64.6 | 1.094 | 81.0 | 0.761 | | |
| 66.8 | 1.205 | 84.6 | 0.905 | | |

| Iso Propyl Alcohol | | Normal Butyl Alcohol | | Iso Butyl Alcohol | |
|---|---|---|---|---|---|
| t° | Gm. Mols. Mannoside per 100 gm. mols. $C_3H_7OH$ | t° | Gm. Mols. Mannoside per 100 gm. mols. $C_4H_9OH$ | t° | Gm. Mols. Mannoside per 100 gm. mols. $C_4H_9OH$ |
| 46.3 | 0.0876 | 45.8 | 0.0539 | 46.1 | 0.0528 |
| 51.6 | 0.129 | 56.1 | 0.107 | 51.1 | 0.0746 |
| 57.3 | 0.164 | 56.2 | 0.109 | 56.0 | 0.104 |
| 60.8 | 0.206 | 62.7 | 0.165 | 63.5 | 0.154 |
| 65.7 | 0.254 | 67.5 | 0.219 | 69.4 | 0.221 |
| 68.0 | 0.276 | 73.1 | 0.290 | 74.3 | 0.285 |
| 73.8 | 0.362 | 91.1 | 0.632 | 80.1 | 0.363 |
| 79.7 | 0.486 | | | 83.0 | 0.420 |

| Secondary Butyl Alcohol | | Tertiary Butyl Alcohol | | Allyl Alcohol | |
|---|---|---|---|---|---|
| t° | Gm. Mols. Mannoside per 100 gm. mols. $C_4H_9OH$ | t° | Gm. Mols. Mannoside per 100 gm. mols. $C_4H_9OH$ | t° | Gm. Mols. Mannoside per 100 gm. mols. $C_3H_5OH$ |
| 49.7 | 0.107 | 38.0 | 0.102 | 46.2 | 0.197 |
| 53.9 | 0.140 | 41.4 | 0.114 | 49.4 | 0.229 |
| 58.6 | 0.175 | 55.0 | 0.200 | 53.3 | 0.275 |
| 66.7 | 0.251 | 60.9 | 0.258 | 58.55 | 0.345 |
| 75.6 | 0.367 | 71.7 | 0.402 | 60.5 | 0.391 |
| 80.5 | 0.440 | 83.8 | 0.613 | 63.2 | 0.436 |
| 93.9 | 0.768 | | | 70.3 | 0.581 |

## *n* Methyl **PIPERIDINE** $C_5H_{10}N.CH_3$

RECIPROCAL SOLUBILITY OF METHYL PIPERIDINE AND WATER.
(Flashner, 1908.)

| t° | Gms. $C_5H_{10}N.CH_3$ per 100 gms. sat. sol. | t° | Gms. $C_5H_{10}N.CH_3$ per 100 gms. sat. sol. | t° | Gms. $C_5H_{10}N.CH_3$ per 100 gms. sat. sol. |
|---|---|---|---|---|---|
| 77 | 5.3 | 48.5 | 21.3 | 85.5 | 83.4 |
| 69.5 | 5.8 | 48.7 | 26.9 | 112.0 | 89.6 |
| 63.6 | 6.4 | 49.5 | 37.2 | 230.4 | 83.4 |
| 54.1 | 8.0 | 51.2 | 46.3 | 275. + | 65.3 |
| 50.3 | 10.3 | 55.0 | 55.9 | 236. | 13.5 |
| 48.7 | 13.0 | 61.5 | 65.3 | 196 | 8.8 |
| 48.3(1) | 16.7 | 70.0 | 74.2 | 178 | 5.3 |

(1) Lower critical temperature. The upper critical temperature is higher than 280°.

DISTRIBUTION OF *n* METHYL PIPERIDINE AT 25° BETWEEN : (Smith, 1921, 1922.)

Water and Ether.

| Millimols. $C_5H_{10}N.CH_3$ per liter of | | |
|---|---|---|
| $H_2O$ layer ($C_1$). | $(C_2H_5)_2O$ layer ($C_2$). | $\frac{C_2}{C_1}$. |
| 0.805 | 1.37 | 1.70 |
| 1.33 | 2.31 | 1.74 |
| 2.065 | 3.59 | 1.74 |
| 3.42 | 6.20 | 1.81 |
| 5.92 | 10.92 | 1.85 |

Water and Xylene.

| Millimols. $C_5H_{10}N.CH_3$ per liter of | | |
|---|---|---|
| $H_2O$ layer ($C_1$). | Xylene layer. ($C_2$). | $\frac{C_2}{C_1}$. |
| 0.683 | 0.934 | 1.365 |
| 1.05 | 1.325 | 1.260 |
| 1.70 | 2.300 | 1.350 |
| 1.85 | 2.575 | 1.390 |
| 2.40 | 3.40 | 1.420 |
| 3.70 | 6.21 | 1.640 |
| 7.33 | 12.67 | 1.725 |

Acetone and Glycerol.

| Millimols. $C_5H_{10}N.CH_3$ per liter of | | |
|---|---|---|
| Acetone layer (A). | Glycerol layer (G). | $\frac{A}{G}$. |
| 0.29 | 1.03 | 0.282 |
| 0.65 | 1.30 | 0.500 |
| 1.375 | 2.00 | 0.687 |
| 3.10 | 3.50 | 0.886 |
| 6.10 | 6.60 | 0.954 |
| 11.15 | 11.05 | 1.010 |
| 22.2 | 20.8 | 1.068 |

**PIPECOLINE** $C_5H_9(CH_3)NH$ *d* and *l*.

F.-pt. data for mixtures of *d* and *l* pipecoline are given by Ladenburg and Sobecki (1910).

PROPYL URETHAN $C_3H_7NHCOOC_2H_5$.

100 gms. $H_2O$ dissolve 8.34 gm. $C_6H_{13}O_2N$ at 15.5°. (Führer, 1924.)

## LEUCINES $C_6H_{13}O_2N$

### Solubility of dl Isoleucine, d Isoleucine, dl Leucine l Leucine and dl Norleucine, Each Separately in Water.

(Dalton and Schmidt, 1933, 1935.)

The following values were derived from solubility equations calculated in each case from a series of from 18 to 40 very careful determinations at 9 to 10 different temperatures between 0 and 70°.

| t° | Gms. of each compound separately per 100 gms. $H_2O$ | | | | |
|---|---|---|---|---|---|
| | dl Leucine $(CH_3)_2CHCH_2CH(NH_2)COOH$ | l Leucine $(CH_3)_2CHCH_2CH(NH_2)COOH$ | dl Isoleucine $CH_3CH_2CH(CH_3)CHNH_2COOH$ | d Isoleucine $CH_3CH_2CHCH_3CHNH_2COOH$ | dl Norleucine $CH_3(CH_2)_3CH(NH_2)COOH$ |
| 0 | 0.797(0.8812) | 2.270 | 1.826(1.750) | 3.791 | 0.843(0.9085) |
| 5 | 0.823 | 2.281 | 1.884 | 3.830 | 0.890 |
| 10 | 0.856 | 2.301 | 1.952 | 3.883 | 0.943 |
| 15 | 0.894 | 2.332 | 2.031 | 3.947 | 1.003 |
| 20 | 0.939 | 2.374 | 2.123 | 4.025 | 1.071 |
| 25 | 0.991(1.181) | 2.426 | 2.229(2.188) | 4.117 | 1.149(1.182) |
| 30 | 1.051 | 2.490 | 2.350 | 4.223 | 1.236 |
| 35 | 1.121 | 2.568 | 2.489 | 4.345 | 1.336 |
| 40 | 1.203 | 2.658 | 2.647 | 4.483 | 1.449 |
| 45 | 1.297 | 2.764 | 2.828 | 4.641 | 1.579 |
| 50 | 1.406(1.764) | 2.887 | 3.034(3.020) | 4.818 | 1.727(1.800) |
| 55 | 1.531 | 3.028 | 3.270 | 5.017 | 1.895 |
| 60 | 1.678 | 3.189 | 3.539 | 5.240 | 2.088 |
| 65 | 1.848 | 3.374 | 3.848 | 5.488 | 2.309 |
| 70 | 2.046 | 3.584 | 4.201 | 5.765 | 2.566 |
| 75 | 2.276(2.840) | 3.823 | 4.607(4.827) | 6.076 | 2.861(2.881) |
| 100 | 4.206(4.83) | 5.638 | 7.802(9.04) | 8.255 | 5.229(4.70) |

The results in parentheses are by Dunn, Ross and Read, 1933.

The results of Pfeiffer and Würgler, 1916, and others agree fairly well with the above values for dl Leucine.

The results of Takahashi and Yaginuma, 1928,1929, agree well with the above values for l Leucine.

The following specific gravity determinations at 25° are given by Dalton and Schmidt:

| Compound | Gms. compound per : 100 gms. sat. sol. | 100 gms. $H_2O$ | Sp. Gr. |
|---|---|---|---|
| dl Leucine | 1.029 | 1.039 | 0.99883 |
| l Leucine | 2.341 | 2.397 | 1.00146 |
| " " | 1.147 | 1.160 | 0.99917 |
| dl Isoleucine | 2.114 | 2.159 | 1.00115 |
| " " | 1.034 | 1.045 | 0.99903 |
| d Isoleucine | 4.341 | 4.538 | 1.00579 |
| " " | 3.328 | 3.442 | 1.00374 |
| " " | 2.259 | 2.312 | 1.00157 |
| " " | 1.289 | 1.306 | 0.99953 |
| dl Norleucine | 1.176 | 1.199 | 0.99908 |

100cc of cold saturated solution of l Leucine in aqueous sat. $Mg(ClO_4)_2$ solution contain 2.0 gms. $C_6H_{13}O_2N$. (Duclaux and Durand-Gasselin, 1938.)

## LEUCINES $C_6H_{13}O_2N$.

### Solubility of l Leucine in Aqueous Solutions of Hydrochloric Acid.

(Takahashi and Yaginuma, 1929.)

Results at 15°

| d. of sat. sol. | Gms. per 100 gms. sat. sol. HCl | Gms. per 100 gms. sat. sol. $C_6H_{13}O_2N$ | Solid Phase |
|---|---|---|---|
| 1.000 | 0.0 | 2.25 | L |
| 1.001 | 0.18 | 2.53 | " |
| 1.020 | 1.64 | 8.89 | " + $L_2$.HCl |
| 1.051 | 5.92 | 17.8 | $L_2$.HCl |
| 1.073 | 9.17 | 24.67 | " |
| 1.079 | 10.18 | 27.25 | " + L.HCl.$H_2O$ |
| 1.078 | 11.90 | 19.99 | L.HCl.$H_2O$ |
| 1.108 | 15.73 | 11.43 | " |
| 1.109 | 17.42 | 10.59 | " + L.HCl |
| 1.102 | 19.17 | 7.83 | L.HCl |
| 1.110 | 20.66 | 8.17 | " |
| 1.130 | 25.58 | 4.68 | " |
| 1.136 | 27.14 | 4.53 | " |
| 1.163 | 32.52 | 4.18 | " |
| 1.177 | 34.99 | 4.58 | " |

Results at 30°

| d. of sat. sol. | Gms. per 100 gms. sat. sol. HCl | Gms. per 100 gms. sat. sol. $C_6H_{13}O_2N$ | Solid Phase |
|---|---|---|---|
| 1.000 | 0.00 | 2.32 | L |
| 1.003 | 0.49 | 4.61 | " |
| 1.012 | 1.28 | 7.10 | " |
| 1.021 | 1.97 | 9.74 | " + $L_2$.HCl |
| 1.031 | 3.11 | 11.31 | $L_2$.HCl |
| 1.061 | 8.12 | 23.81 | " |
| 1.088 | 11.53 | 33.14 | " + L.HCl.$H_2O$ |
| 1.092 | 12.03 | 28.39 | L.HCl.$H_2O$ |
| 1.095 | 14.44 | 18.16 | " |
| 1.087 | 15.49 | 15.31 | " |
| — | 17.42 | 14.06 | " + L.HCl |
| 1.110 | 21.54 | 6.88 | L.HCl |
| 1.142 | 28.44 | 4.43 | " |
| 1.164 | 32.38 | 4.85 | " |
| 1.191 | 39.28 | 5.92 | " |

L = $C_6H_{13}O_2N$ (l Leucine).

### Solubility of *d. l* Leucine in Water and in Aqueous Solutions of Salts at 20°. (Pfeiffer and Würgler, 1916.)

| Gms. mols. salt per liter solvent | Gms. Leucine per liter sat. sol. |
|---|---|
| 0.0 (Water) | 9.76 |
| 1.27 Mol. LiCl | 9.45 |
| 2.28 " " | 8.66 |
| 2.54 " " | 8.93 |
| 5.07 " " | 9.85 |
| 11.4 " " | 9.13 |
| 0.5 " NaCl | 8.86 |
| 1.0 " " | 8.08 |
| 2.0 " " | 6.70 |
| 4.0 " " | 3.87 |
| Sat. sol. " | 2.49 |
| 0.5 Mol. KCl | 8.93 |
| 1.0 " " | 8.01 |
| 2.0 " " | 6.37 |
| Sat. sol. " | 3.55 |
| 2.0 Mol. KBr | 7.09 |
| 2.0 " KI | 8.01 |
| 2.0 " $KNO_3$ | 9.19 |
| 0.297 " $CaCl_2$ | 10.75 |
| 0.571 " " | 12.43 |
| 0.594 " " | 11.51 |
| 1.18 " " | 12.68 |
| 2.37 " " | 13.96 |

| Gms. mols. salt per liter solvent | Gms. Leucine per liter sat. sol. |
|---|---|
| 0.25 Mol. $BaCl_2$ | 10.61 |
| 0.50 " " | 11.28 (11.49) |
| 1.00 " " | 11.17 |
| 0.25 " $SrCl_2$ | 10.34 |
| 0.50 " " | 10.98 (11.49) |
| 1.0 " " | 10.82 |
| 2.0 " " | 10.34 |
| 0.487 " $BaBr_2$ | 12.08 |
| 0.457 " $Ba(ClO_4)_2$ | 13.15 |
| 0.1 " HCl | 22.19 |
| 0.1 " " + 1.94 mol. LiCl | 14.12 |
| 0.1 " " + 2.0 " KCl | 18.29 |
| 0.1 " " + 2.0 " $KNO_3$ | 20.04 |
| 0.1 " NaOH | 22.74 |
| 0.1 " " + 2.06 mol. LiCl | 21.25 |
| 0.1 " " + 2.0 " NaCl | 19.11 |
| 0.1 " " + 2.0 " KCl | 19.19 |
| 0.1 " " + 2.0 " KBr | 19.66 |
| 0.1 " " + 2.0 " $KNO_3$ | 20.59 |
| 0.5 " " | 14.41 |
| 0.5 " " + 2.04 mol. $LiCl$ | 13.75 |
| 0.5 " " + 2.0 " NaCl | 13.41 |
| 0.5 " " + 2.0 " $NaNO_3$ | 13.52 |

The above determinations were made by shaking the mixtures in a thermostat for 9 days and titrating the clear solution by the Sörensen method. A titration after an additional period of 1 day showed that complete saturation had been reached in all cases.

### Solubility of Leucine in Aqueous Solutions of Different Hydrogen Ion Concentration at 25°. (Sano, 1926.)

A large excess of leucine was shaken in a thermostat at 25° with the aqueous solvent. The saturated solution was filtered and a portion used for the determination of $p_H$ by means of the hydrogen electrode and another portion for the determination of nitrogen by the micro Kjeldahl method using iodometric titration according to Bang.

| Aq. solvent | $p_H$ of sat. sol. | Gms. N per liter sat. sol. | Aq. solvent. | $p_H$ of sat. sol. | Gms N per liter sat. sol |
|---|---|---|---|---|---|
| 0.333 *n* HCl ..... | 2.15 | 7.339 | 0.005 *n* NaOH.. | 8.36 | 2.898 |
| 0.100 *n* » ..... | 2.49 | 4.719 | 0.05 *n* » .. | 9.12 | 3.742 |
| 0.02 *n* » ..... | 3.07 | 3.298 | 0.10 *n* » .. | 9.41 | 4.659 |
| 0.10 *n* $CH_3COOH$.... | 3.51 | 2.915 | 0.40 *n* » .. | 9.81 | 7.137 |
| 0.01 *n* $CH_3COOH$ + .. ) | 6.00 | 2.588 | | | |
| 0.1 *n* $CH_3COONa$.. ) | | | | | |

The minimum solubility at the isoelectric point is 2.588 gms. N. or 24.24 gm. leucine per liter at 25°.

### Solubility of Leucine in Water and in Aqueous Salt Solutions at 21°.

(Pfeiffer and Angern, 1924.)

A saturated aqueous solution of the amino acid was prepared by constant shaking in a thermostat for 3 days. To five cc. portions of this sat. solution amounts of the salts to yield 0.02 molecular concentration were added and the shaking continued for another 3 days. The amino acid salted out was filtered, dried at 120-130° and weighed. That remaining in solution was calculated by difference.

| Solvent. | Gms. Leucine per liter sat. solution. |
|---|---|
| Water ..... | 22.24 |
| Aq. 0.02 mol. $CH_3COOK$ per liter..... | 19.36 |
| » 0.02 » $(NH_4)SO_4$ » ..... | 9.12 |
| » 0.02 » NaCl » ..... | 13.94 |

One liter sat. solution of **d, l, leucine** in water contains 10.11 gms., and one liter sat. solution in Aq. 0.1 *n* HCl contains 13.16 gms. of the compound at 21°.
(von Euler and Rudberg 1924, 1925.)

### Solubility of Isomeric Leucines, Each Separately, in Aqueous Solutions of Ethyl Alcohol at 25°.

(Cohn, McMeekin, Edsall and Weare, 1934; McMeekin, Cohn and Weare, 1936.)

| Vol. Percent $C_2H_5OH$ in Aq. Solvent | Gm. Mols. of Each Isomer Separately per liter sat. solution | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | dl Leucine (dl α Amino isocaproic acid) | | l Leucine (l-α Amino isocaproic acid) | | — (ε-Amino Caproic acid; M.PT. 201-2°) | | dl Norleucine (dl α Amino n caproic acid) | |
| 0.0(=$H_2O$) | (0.9988) | 0.0744 | (1.0012) | 0.171 | (1.0895) | 3.848 | (0.9991) | 0.0866 |
| 5 | (0.9917) | 0.0661 | — | — | (1.0834) | 3.733 | (0.9920) | 0.0781 |
| 10 | (0.9854) | 0.0575 | — | — | (1.0794) | 3.625 | (0.9855) | 0.0688 |
| 15 | (0.9793) | 0.0494 | — | — | — | — | (0.9795) | 0.0598 |
| 20 | (0.9735) | 0.0423 | (0.9748) | 0.0977 | (1.0662) | 3.439 | (0.9726) | 0.0516 |
| 40 | (0.9467) | 0.0264 | (0.9469) | 0.0620 | (1.0326) | 2.852 | (0.9460) | 0.0346 |
| 60 | (0.9067) | 0.0186 | (0.9071) | 0.0441 | (0.9707) | 1.909 | (0.9060) | 0.0271 |
| 80 | (0.8560) | 0.00848 | (0.8569) | 0.0204 | (0.8742) | 0.485 | (0.8550) | 0.0130 |
| 90 | — | — | (0.8254) | 0.00770 | (0.8304) | 0.0713 | (0.8254) | 0.00585 |
| 95 | — | — | — | — | (0.80848) | 0.0139 | — | — |
| 100 | — | — | (0.7851) | 0.00128 | (0.7851) | 0.00194 | (0.7851) | 0.00104 |

The figures in parentheses are densities.

## Solubility of dl Leucine and of dl Norleucine in Aqueous Solutions of Ethyl Alcohol at Several Temperatures.

(Dunn and Ross, 1938.)

### Results for dl Leucine

| t° | Vol. Percent $C_2H_5OH$ in Solvent | d. of sat. sol. | Gms. dl Leucine per 100 gms. solvent |
|---|---|---|---|
| 0 | 24.93 | 0.971 | 0.251 |
| " | 50.10 | 0.935 | 0.118 |
| " | 74.50 | 0.881 | 0.0693 |
| " | 95.14 | 0.819 | 0.0116 |
| 25 | 24.93 | 0.964 | 0.493 |
| " | 50.10 | 0.924 | 0.318 |
| " | 74.20 | 0.868 | 0.175 |
| " | 95.14 | 0.806 | 0.0258 |
| 45.2 | 24.93 | 0.958 | 0.853 |
| " | 50.10 | 0.912 | 0.633 |
| " | 74.5 | 0.856 | 0.323 |
| " | 95.14 | 0.795 | 0.0471 |
| 65.1 | 24.93 | 0.948 | 1.45 |
| " | 50.10 | 0.900 | 1.16 |
| " | 74.20 | 0.844 | 0.584 |
| " | 95.09 | 0.780 | 0.0844 |

### Results for dl Norleucine

| t° | Vol. Percent $C_2H_5OH$ in Solvent | d. of sat. sol. | Gms. dl Norleucine per 100 gms. solvent |
|---|---|---|---|
| 0 | 24.93 | 0.972 | 0.275 |
| " | 50.10 | 0.938 | 0.147 |
| " | 74.50 | 0.883 | 0.0995 |
| " | 95.14 | 0.819 | 0.0192 |
| 25.7 | 24.93 | 0.965 | 0.625 |
| " | 50.1 | 0.924 | 0.453 |
| 25.0 | 74.2 | 0.868 | 0.266 |
| " | 94.14 | 0.806 | 0.417 |
| 45.0 | 24.93 | 0.957 | 1.12 |
| " | 50.10 | 0.913 | 0.918 |
| " | 74.20 | 0.855 | 0.518 |
| " | 95.14 | 0.793 | 0.0759 |
| 65.2 | 24.93 | 0.948 | 2.02 |
| " | 50.10 | 0.902 | 1.76 |
| " | 74.20 | 0.842 | 0.941 |
| " | 95.14 | 0.780 | 0.134 |

## Distribution of Leucine and of Norleucine, Each Separately, Between Water and Butyl Alcohol at 25°.

(England, Jr., and Cohn, 1936.)

### Results for Leucine

| Gm. Mols. Leucine per liter | | $\frac{2}{1}$ |
|---|---|---|
| $H_2O$ layer(1) | Alcohol layer(2) | |
| 0.023 | 0.0043 | 0.183 |
| 0.047 | 0.0088 | 0.187 |
| 0.101 | 0.0204 | 0.202 |

### Results for Norleucine

| Gm. Mols. Norleucine per liter | | $\frac{2}{1}$ |
|---|---|---|
| $H_2O$ layer(1) | Alcohol layer(2) | |
| 0.020 | 0.0061 | 0.310 |
| 0.067* | 0.0204 | 0.328 |

* Excess solid present.

## Solubility of dl α Amino n Caproic Acid (dl Norleucine) in Several Solvents at 25°.

(McMeekin, Cohn and Weare, 1936.)

| Solvent | d. of sat. solution | Gm. Mols $C_6H_{13}O_2N$ per liter sat. sol. |
|---|---|---|
| Water | 0.9991 | 0.0866 |
| Formamide | 1.1309 | 0.0173 |
| Methanol | 0.7873 | 0.00854 |
| Ethanol | 0.7851 | 0.00104 |
| Butanol | 0.8067 | 0.000336 |
| Acetone | 0.7857 | 0.0000793 |

100 cc Butyric acid dissolve 0.024 gm. Leucine at 18°.
(v. Przylecki and Kasprzyk-Czaykowski, 1938.)

Results for the solubility of methyl, ethyl and propyl Leucine hydrochlorides in methyl, ethyl and propyl alcohols at various temperatures are given by Takahashi and Yaginuma, 1930, and Yaginuma, 1930.

**HEXANE** $n\,CH_3(CH_2)_4CH_3$.

100 gms. sat. solution of hexane in water contain about 0.014 gm. $C_6H_{14}$ at 15°.5. (Fühner, 1922.)

100 gms. aq. 0.4 Ω Sodium Oleate solution (= 10.8 gm. Na oleate per 100 gms. sol.) dissolve 2.4 gms. Hexane at 20° when dissolved directly and 7.3 gms. when mixed with oleic acid and the necessary amount of NaOH to neutralize the oleic acid is added.

100 gms. sat. solution of hexane in 92 wt. % alcohol contain 46.4 gm. $C_6H_{14}$ at 15°. (Ormandy and Craven. 1921.)

The critical solution temperature of hexane + methyl alcohol is at 42° and the mixture contains 80 per cent hexane. A mixture of equal weights of hexane and methyl alcohol has a mutual miscibility temperature of 35°.5. The effect of increasing amounts of water and of salts upon this temperature was studied. (Howard and Patterson, 1926.)

### Solubility of Hexane in Methyl Alcohol.

(Rothmund, 1898.)

Determined by synthetic method, see p. 292

| t°. | Gms. Hexane per 100 Gms. Alcoholic Layer. | Hexane Layer. | t°. | Gms. Hexane per 100 Gms. Alcoholic Layer. | Hexane Layer. |
|---|---|---|---|---|---|
| 10 | 26.5 | 96.8 | 35 | 43.6 | 91.2 |
| 20 | 31.6 | 95.9 | 40 | 52.7 | 85.5 |
| 30 | 38.3 | 93.7 | 42.6 | (crit. t.) 68.9 | |

### Equilibrium in the System Ω Hexane, Phenol and Water.

(Vondracek and Dostal, 1936.)

To mixtures of weighed amounts of phenol and water, weighed amounts of hexane were added and the temperature determined at which turbidity appeared. From the series of determinations the compositions corresponding to the temperatures 20° and 30° were ascertained by graphical interpolation.

Results at 20°

| Gms. per 100 gms. sat. solution | | |
|---|---|---|
| $C_6H_{14}$ C H | $C_6H_5OH$ | $H_2O$ |
| 10.03 | 85.69 | 4.28 |
| 8.55 | 85.48 | 5.97 |
| 7.39 | 84.20 | 8.41 |
| 6.57 | 83.44 | 9.99 |
| 5.66 | 82.03 | 12.31 |
| 4.76 | 79.39 | 15.85 |
| 3.77 | 74.05 | 22.18 |

Results at 30°

| Gms. per 100 gms. sat. solution | | |
|---|---|---|
| $C_6H_{14}$ | $C_6H_5OH$ | $H_2O$ |
| 11.74 | 84.06 | 4.20 |
| 10.00 | 84.12 | 5.88 |
| 8.69 | 83.02 | 8.29 |
| 7.75 | 82.38 | 9.87 |
| 6.80 | 81.05 | 12.15 |
| 5.68 | 78.62 | 15.70 |
| 4.51 | 73.48 | 22.01 |

### Critical Solution Temperatures of Mixtures of Hexane and Other Compounds.

| Mixture of Hexane and:- | C.S.t° | Wt. % $C_6H_{14}$ in mixture | Authority |
|---|---|---|---|
| Ω Toluidine | 21.1 | 64.0 | Thiry, 1925. |
| Ω " | 21.05 | 54.5 | Hartenberg, 1926. |
| m " | 21.3 | 52.3 | Thiry, 1925. |
| m " | 21.3 | 55.8 | Dessart, 1926. |
| m Nitro Toluene | -30.0(calc.) | — | " " |
| Nitro benzene | 19.0 | — | " " |
| Aniline | 70.0 | — | " " |

### Equilibrium in the Ternary System Hexane, Nitrobenzene and Resorcinol.

(Timofiew and Stachorskij, 1926.)

The authors determined the temperatures of clouding, corresponding to the formation of two layers, in various mixtures of the three liquids.

| Wt. Percent of Hexane mixed with Nitrobenzene | $t^0$ of clouding in final mixture containing: | | | |
|---|---|---|---|---|
| | 0.0 | 0.05 | 0.10 | 0.15 Wt. percent Resorcinol |
| 30.0 | 5.97 | 6.10 | 6.35 | 6.60 |
| 34.94 | 8.70 | 8.90 | 9.22 | 9.50 |
| 39.92 | 9.90 | 10.23 | 10.50 | 10.75 |
| 42.40 | 10.28 | 10.58 | 10.98 | 11.40 |
| 45.99 | 10.38 | 10.80 | 11.26 | 11.66 |
| 54.86 | 10.14 | 10.88 | 11.62 | 12.35 |
| 65.05 | 8.54 | 9.78 | 11.02 | 12.26 |
| 69.82 | 6.50 | 8.70 | 10.60 | 12.12 |

## HEXANE

### Equilibrium in the Ternary System Hexane, Nitrobenzene and o Nitrophenol.

(Timofeiw and Stachorsky, 1926.)

| Wt. Percent Hexane mixed with Nitrobenzene | $t^0$ of clouding in final mixture containing: | | | |
|---|---|---|---|---|
| | 0.0 | 0.5 | 1.0 | 1.5 Wt. percent o nitrophenol |
| 30.0 | 6.05 | 6.07 | 6.10 | 6.13 |
| 34.94 | 8.70 | 8.73 | 8.80 | 8.91 |
| 39.92 | 9.90 | 10.02 | 10.15 | 10.28 |
| 42.40 | 10.28 | 10.38 | 10.51 | 10.66 |
| 45.99 | 10.38 | 10.55 | 10.71 | 10.87 |
| 54.86 | 10.14 | 10.35 | 10.57 | 10.78 |
| 65.05 | 8.54 | 8.93 | 9.28 | 9.58 |
| 69.82 | 6.50 | 7.05 | 7.50 | 7.86 |

### Equilibrium in the Ternary Systems Hexane, Nitrobenzene and:

(Timofeiw and Stachorsky, 1926.)

| Wt. Percent Hexane mixed with Nitrobenzene in each case | Benzoic acid: $t^0$ of clouding in final mixtures containing: | | | | Butyric acid: $t^0$ of clouding in final mixtures containing: | | Valeric acid: $t^0$ of clouding in final mixtures containing: | |
|---|---|---|---|---|---|---|---|---|
| | 0.0 | 0.5 | 1.0 | 2.0 | 0.5 | 1.0 | 0.5 | 1.0 |
| | Wt. % Benzoic acid | | | | Wt. % Butyric acid | | Wt. % Valeric acid | |
| 30.0 | 6.20 | 5.82 | 5.42 | 4.93 | 5.22 | 4.44 | 4.78 | 3.80 |
| 34.85 | 8.70 | 8.44 | 8.16 | 7.53 | 7.82 | 6.90 | 7.50 | 6.50 |
| 39.9 | 10.0 | 9.88 | 9.66 | 9.22 | 9.06 | 8.22 | 8.92 | 7.92 |
| 46.4 | 10.4 | 10.34 | 10.17 | 9.60 | 9.56 | 8.74 | 9.47 | 8.57 |
| 54.86 | 10.14 | — | — | — | 9.32 | 8.47 | 9.28 | 8.37 |
| 59.91 | 9.83 | 9.74 | 9.42 | 8.81 | — | — | — | — |
| 64.93 | 8.5 | 8.50 | 8.36 | 7.75 | 7.75 | 6.94 | 7.70 | 6.9 |
| 69.96 | 6.45 | 6.40 | 6.26 | 5.77 | 5.73 | 4.90 | 5.77 | 4.97 |

THE MUTUAL SOLUBILITY OF HEXANE AND SULFUR DIOXIDE. (Seyer and Gill, 1924.)

Highly purified products were used. The mixtures were sealed in bulbs and the temperatures of appearance and disappearance of turbidity carefully determined.

| t°. | Wt. per cent $C_6H_{14}$ in mixture. | t° | Wt. per cent $C_6H_{14}$ in mixture. | t°. | Wt. per cent $C_6H_{14}$ in mixture. |
|---|---|---|---|---|---|
| —93.7..... | 100.0 | +3.0..... | 69.3 | 8.6..... | 7.3 |
| —96 (Eutectic). | – | 7.0..... | 61.5 | 7.0..... | 5.3 |
| —31..... | 88.8 | 7.1..... | 57.3 | —20.3..... | 3.3 |
| —30..... | 88.4 | 10.0..... | 41.0 | —61.5..... | 1.0 |
| —28.1..... | 88.0 | 10.1..... | 32.4 | —73.5 (Eutectic) | – |
| —19.0..... | 84.1 | 9.9..... | 18.5 | —72.8..... | 0.0 |
| — 3.3..... | 75.5 | 9.0..... | 11.75 | | |

Later determinations reported by Seyer and Todd, 1931, are as follows:

| t° | Wt. percent $C_6H_{14}$ in mixture | t° | Wt. Percent $C_6H_{14}$ in mixture | t° | Wt. percent $C_6H_{14}$ in mixture |
|---|---|---|---|---|---|
| -53 | 86.0 | 10.6 | 43.6 | 3.8 | 10.8 |
| -22 | 78.0 | 10.2(1) | 34 | 2.5 | 9.8 |
| -17 | 75.8 | 10.2 | 32.4 | -10.0 | 4.6 |
| + 8 | 53.4 | 9.8 | 18.6 | -20 | 3.3 |
| 9.9 | 49.3 | 6.5 | 13.0 | | |

(1) Upper critical solution temperature.

The critical solution temperature of mixtures of Hexane and Sulfur Dioxide is 12° and the reciprocal solubility curve at this temperature is practically flat between the concentrations 70 and 90 gm. mol. percent $SO_4$. (Leslie, 1934.)

## 2-METHYL PENTANE $(CH_3)_2CH(CH_2)_2CH_3$.

EQUILIBRIUM IN THE SYSTEM 2-METHYL PENTANE, PHENOL AND WATER. (Vondracek and Dostal, 1936.)

To mixtures of weighed amounts of phenol and water, weighed amounts of 2-methyl pentane were added and the temperatures determined at which turbidity appeared. From this series of determinations the compositions corresponding to the temperatures 20° and 30° were ascertained by graphical interpolation.

Results at 20°

| Gms. per 100 gms. sat. solution | | |
|---|---|---|
| $C_6H_{14}$ | $C_6H_5OH$ | $H_2O$ |
| 4.30 | 9.61 | 86.09 |
| 8.43 | 7.23 | 84.34 |
| 12.26 | 5.87 | 81.87 |
| 15.85 | 4.76 | 79.39 |
| 19.15 | 4.14 | 76.71 |
| 22.21 | 3.62 | 74.17 |

Results at 30°

| Gms. per 100 gms. sat. solution | | |
|---|---|---|
| $C_6H_{14}$ | $C_6H_5OH$ | $H_2O$ |
| 4.21 | 11.53 | 84.26 |
| 8.31 | 8.47 | 83.22 |
| 12.11 | 7.01 | 80.88 |
| 15.69 | 5.75 | 78.56 |
| 19.00 | 4.85 | 76.15 |
| 22.07 | 4.75 | 73.68 |

The critical solution temperature of mixtures of 2-Methyl Pentane and Sulfur dioxide is 10° and the reciprocal solubility curve at this temperature is practically flat between the concentrations 50 and 90 gm. mol. percent $SO_4$. (Leslie, 1934.)

Freezing-point data are given for mixtures of Hexane and:

| | | |
|---|---|---|
| Benzene(5)(8) | Iso pentane(9) | Nitro toluene(2) |
| Chloroform(8) | Methyl cyclohexane(9) | Phenol(3) |
| Cyclohexane(8) | Nitro benzaldehyde(7) | Toluidines(2)(4) |
| Di cetyl(dotria contane)(6) | Nitro benzene(1)(4)(7) | |

(1) Deffet, 1938; (2) Dessart, 1926; (3) Campetti and Delgrosso, 1913; (4) Hartenberg, 192 ; (5) Ormandy and Craven, 1926; (6) Seyer, 1938; (7) Timmermans, 1907, 1911; (8) Timmermans, 1928; (9) Timmermans, 1934.

## HEXYL ALCOHOL $n\,CH_3(CH_2)_4CH_2OH$.

### Solubility of *n* Hexyl Alcohol in Water. (Fühner, 1924.)

The determinations were made by the synthetic method, and from the curve obtained the following results were read.

| t°. | Gms. $C_6H_{14}O$ per 100 gms. sat. sol. | t°. | Gms. $C_6H_{14}O$ per 100 gms. sat. sol. | t°. | Gms. $C_6H_{14}O$ per 100 gms. sat. sol. |
|---|---|---|---|---|---|
| 0..... | 0.78 | 40..... | 0.52 | 80..... | 0.62 |
| 10..... | 0.67 | 50..... | 0.515 | 90..... | 0.68 |
| 20..... | 0.59 | 60..... | 0.53 | 100..... | 0.785 |
| 30..... | 0.545 | 70..... | 0.565 | 110..... | 0.89 |

A saturated solution of n Hexyl alcohol in water, analyzed by interferometer readings, was found to contain 0.624 gm. $C_6H_4O$ per 100 gms. sat. sol. at 25°. (Butler, Thomson and MacLennen, 1933.)

### Reciprocal Solubility of Isomeric Hexanols, Each Separately, in Water.

(Ginnings, and Webb, 1938.)

| Hexanol | d. of pure hexanol | t° | Gms. $C_6H_{13}OH$ per 100 gms. $H_2O$ rich phase | | Hexanol rich phase | |
|---|---|---|---|---|---|---|
| Diethyl methyl carbinol | 0.8242 | 20 | (0.9933) | 4.82 | (0.8498) | 89.53 |
| " " " | " | 25 | (0.9926) | 4.26 | (0.8454) | 89.64 |
| " " " | " | 30 | (0.9919) | 3.81 | (0.8410) | 89.76 |
| Dimethyl-i-propyl " | 0.8118 | 20 | (0.9934) | 4.65 | (0.8464) | 89.06 |
| " " " | " | 25 | (0.9929) | 4.18 | (0.8421) | 89.12 |
| " " " " | " | 30 | (0.9910) | 3.76 | (0.8372) | 89.26 |
| Dimethyl-n-propyl " | 0.8053 | 20 | (0.9935) | 3.63 | (0.8321) | 89.87 |
| " " " | " | 25 | (0.9929) | 3.24 | (0.8280) | 89.95 |
| " " " | " | 30 | (0.9921) | 2.96 | (0.8237) | 89.99 |
| t-Butyl methyl " | 0.8157 | 20 | (0.9955) | 2.64 | (0.8356) | 92.74 |
| " " " | " | 25 | (0.9946) | 2.43 | (0.8313) | 92.71 |
| " " " | " | 30 | (0.9936) | 2.26 | (0.8272) | 92.67 |
| i-Propyl ethyl " | 0.8186 | 20 | (0.9950) | 2.24 | (0.8323) | 94.97 |
| " " " | " | 25 | (0.9941) | 2.01 | (0.8288) | 94.89 |
| " " " | " | 30 | (0.9940) | 1.82 | (0.8249) | 94.72 |
| s-Butyl methyl " | 0.8231 | 20 | (0.9960) | 2.09 | (0.8390) | 93.43 |
| " " " | " | 25 | (0.9950) | 1.94 | (0.8356) | 93.32 |
| " " " | " | 30 | (0.9939) | 1.79 | (0.8316) | 93.21 |
| i-Butyl methyl " | 0.8034 | 20 | (0.9956) | 1.79 | (0.8186) | 93.79 |
| " " " | " | 25 | (0.9948) | 1.64 | (0.8149) | 93.65 |
| " " " | " | 30 | (0.9939) | 1.52 | (0.8114) | 93.45 |
| n-Propyl ethyl " | 0.8143 | 20 | (0.9952) | 1.75 | (0.8264) | 95.34 |
| " " " | " | 25 | (0.9951) | 1.61 | (0.8225) | 95.14 |
| " " " | " | 30 | (0.9939) | 1.49 | (0.8190) | 94.93 |
| n-Butyl methyl " | 0.8108 | 20 | (0.9965) | 1.51 | (0.8264) | 93.50 |
| " " " | " | 25 | (0.9954) | 1.37 | (0.8231) | 93.38 |
| " " " | " | 30 | (0.9942) | 1.28 | (0.8194) | 93.25 |
| t-Pentyl " | 0.8498 | 20 | (0.9971) | 0.82 | (0.8598) | 98.28 |
| " " | " | 25 | (0.9963) | 0.76 | (0.8551) | 98.21 |
| " " | " | 30 | (0.9951) | 0.71 | (0.8511) | 98.16 |

The figures in parentheses are densities.

$C_6H_{14}O_1$

## DI n PROPYL ETHER $(C_3H_7)_2O$

### Reciprocal Solubility of Di n Propyl Ether and Water.
(Bennett and Phillip, 1928.)

The determinations were made by the method of Hill, 1923, modified by reducing the scale of the apparatus to require only 4-5 cc of each liquid and adding a globule of Hg to hasten mixing.

| t° | Wt. % $(C_3H_7)_2O$ in Aq. Phase | Wt. % $H_2O$ in Ether Phase | t° | Wt. % $(C_3H_7)_2O$ in Aq. phase | Wt. % $H_2O$ in Ether Phase |
|---|---|---|---|---|---|
| 0 | 1.05 | 0.36 | 20 | 0.54 | 0.38 |
| 10 | 0.71 | 0.29 | 25 | 0.49 | 0.45 |
| 15 | 0.61 | 0.31 | | | |

The authors also give a series of determinations made by the synthetic method using both Di n Propyl Ether and n Propyl iso Propyl Ether.

Results for the Solubility in Water of:

| Di n Propyl Ether | | n Propyl iso Propyl Ether | |
|---|---|---|---|
| t° | Wt. % $C_6H_{14}O$ in Water | t° | Wt. % $C_6H_{14}O$ in Water |
| 0 | 0.58 | 0 | 1.0 +(?) |
| 10 | 0.41 | 10 | 0.75 |
| 15 | 0.38 | 15 | 0.60 |
| 20 | 0.30 | 20 | 0.51 |
| 25 | 0.25 | 25 | 0.47 |

NOTE.—It seems probable that a mistake in recording the above results in the original paper was made and the values for the two isomeric ethers by the synthetic method should be interchanged.

Determinations of the reciprocal solubility of propyl ether and water and of propyl ether and aqueous sulphuric acid are reported with insufficient details by Gajendragad and Jotkar, 1935.

## Mono BUTYL GLYCOL ETHERS, normal and iso $C_6H_{14}O_2$.

### Mutual Solubility of Normal and of Iso Butyl Glycol Ether in Water.
(Cox and Cretcher, 1926.)

These systems give curves which are complete circles, consequently for each concentration of glycol ether there is an upper solution temperature and a lower solution temperature.

Results for *n* Butyl Ether.
(b. pt. = 170°.6; $d_{\frac{15}{15}} = 0.9011$)

| Wt. % *n* Butyl Ether. | Lower solution temp. | Upper solution temp. |
|---|---|---|
| 9.18..... | 75.0 | 86.0 |
| 9.94..... | 65.8 | 97.0 |
| 11.45..... | 57.6 | 109.3 |
| 14.95..... | 51.6 | 120.4 |
| 19.94..... | 49.6 | 126.8 |
| 24.78..... | 49.1 | 128.0 |
| 30.03..... | 49.6 | 127.7 |
| 34.42..... | 50.1 | 126.8 |
| 39.67..... | 51.3 | 125.3 |
| 44.95..... | 53.5 | 122.9 |
| 50.08..... | 58.0 | 117.8 |
| 55.08..... | 67.1 | 107.7 |
| 57.87..... | 80.0 | 94.0 |

Results for *iso* Butyl Ether.
(b. pt. = 158°.8; $d_{\frac{15}{15}} = 0.8950$)

| Wt. % of Iso Butyl Ether. | Lower solution temp. | Upper solution temp. |
|---|---|---|
| 7.57..... | 54.5 | 101.5 |
| 9.97..... | 36.6 | 126.1 |
| 16.68..... | 25.9 | 145.0 |
| 24.51..... | 24.6 | 150.0 |
| 31.54..... | 24.7 | 150.2 |
| 39.70..... | 25.5 | 149.3 |
| 47.46..... | 27.1 | 147.9 |
| 55.80..... | 31.9 | 142.6 |
| 61.80..... | 38.9 | 132.9 |
| 66.13..... | 47.6 | 120.6 |
| 67.70..... | 51.0 | 114.5 |
| 70.86..... | just on curve | |

## PROPYL ETHERS of PROPYLENE GLYCOL (Isomeric) $C_6H_{14}O_2$.

### Reciprocal Solubility of the Isomeric n Propyl Ethers of 1,2-Propylene Glycol, Each Separately, in Water.

(Cox, Nelson and Cretcher, 1927.)

These systems give closed solubility curves.

Results for:

1 - Propxy-propane-2-ol
(d = 0.8886 b.pt. = 148.5-149° at 730mm.)

| Wt. % Ether | Lower solution Temperature | Upper solution Temperature |
|---|---|---|
| 19.7 | 75.0 | 125.5 |
| 13.1 | 57.7 | 145.0 |
| 14.9 | 49.8 | 154.0 |
| 20.0 | 39.5 | 165.5 |
| 24.8 | 35.9 | 170.0 |
| 35.5 | 34.5 | 171.7 |
| 45.2 | 35.0 | 171.2 |
| 55.0 | 36.6 | 168.0 |
| 60.4 | 39.3 | 162.0 |
| 65.2 | 42.7 | 155.5 |
| 69.7 | 49.3 | 144.0 |
| 74.7 | 71.0 | 114.0 |

2-Propoxy-propane-1-ol
(d = 0.8925, b. pt. 150.5-151° at 730mm.)

| Wt. % Ether | Lower solution Temperature | Upper solution Temperature |
|---|---|---|
| 12.1 | 76.0 | 126.0 |
| 14.9 | 57.2 | 143.5 |
| 20.0 | 47.2 | 156.0 |
| 25.4 | 43.8 | 161.0 |
| 30.0 | 42.8 | 162.0 |
| 40.5 | 43.4 | 161.5 |
| 50.3 | 44.7 | 159.5 |
| 60.0 | 48.7 | 151.5 |
| 66.2 | 56.0 | 138.0 |
| 69.3 | 64.7 | 126.0 |

## PINACOL (Pinacone) $C_6H_{12}(OH)_2.6H_2O$ and $H_2O$

### Solubility in Water Determined by the Freezing-Point Method.

(Pushin and Glagoleva, 1922.)

| t°. | Mol. % $C_6H_{12}(OH)_2$. | Solid Phase. | t°. | Mol. % $C_6H_{12}(OH)_2$. | Solid Phase. | t°. | Mol. % $C_6H_{12}(OH)_2$. | Solid Phase. |
|---|---|---|---|---|---|---|---|---|
| − 0.45 eutec. | − | Ice+1.6 | 45.3..... | 17.0 | 1.6 | 41.2..... | 53.3 | 1.1 |
| +16.7..... | 0.50 | 1.6 | 45.2..... | 19.5 | » | 41.0..... | 57.5 | » |
| 22.0..... | 0.86 | » | 45.1..... | 21.9 | » | 39.5..... | 64.8 | » |
| 28.0..... | 1.3 | » | 44.8..... | 24.4 | » | 36.6..... | 70.8 | » |
| 34.7..... | 2.2 | » | 43.3..... | 31.1 | » | 33.7..... | 76.4 | » |
| 37.4..... | 2.7 | » | 41.8..... | 34.3 | » | 29.4 eutec. | 80.4 | » +$C_6H_{12}(OH)_2$ |
| 40.2..... | 3.6 | » | 40.4 eutec. | 36.5 | »+1.1 | 30.2..... | 82.8 | $C_6H_{12}(OH)_2$ |
| 43.7..... | 6.5 | » | 40.7..... | 37.8 | 1.1 | 33.2..... | 87.0 | » |
| 44.9..... | 9.6 | » | 40.6..... | 39.6 | » | 38.6..... | 93.4 | » |
| 45.3..... | 12.7 | » | 41.2..... | 45.0 | » | 39.7..... | 97.0 | » |
| 45.4 m. pt.. | 14.3 | » | 41.25 m.pt. | 50.0 | » | 41.1 m. pt. | 100.0 | » |

1.6 = $C_6H_{12}(OH)_2.6H_2O$; 1.1 = $C_6H_{12}(OH)_2.H_2O$

## MANNITOL $CH_2OH(CHOH)_4CH_2OH$.

### Solubility in Water.

(Findlay, 1902.)

| t°. | Gms. $CH_2OH(CHOH)_4CH_2OH$ per 100 Gms. $H_2O$. | |
|---|---|---|
| 0 | 7.59 | |
| 10 | 11.63 | (13.94 gms. Campetti, 1901) |
| 20 | 17.71 | (18.98 gms. Campetti, 1901) |
| 24.5 | 20.96 | |
| 30 | 25.4 | |
| 35.8 | 29.93 | |
| 40 | 35.4 | |
| 50.8 | 46.69 | |
| 60 | 60.01 | |
| 70 | 74.5 | |
| 80 | 91.5 | |
| 100 | 133.1 | |

100 gms. $H_2O$ dissolve 21.5 gms. $C_6H_{14}O_6$ at 25°. (Hermanns, 1925.)

## MANNITOL $CH_2OH(CHOH)_4CH_2OH$

### Solubility of Mannitol in Water. (Braham, 1919.)

The determinations were made with the greatest care. The results were plotted on a large scale diagram and the following values for regular intervals of temperature were obtained.

| t.° | Gms. $CH_2OH(CHOH)_4CH_2OH$ per 100 gms. $H_2O$. | Mol. fraction Mannitol In solution. |
|---|---|---|
| — 1.019 (Eutec.) | 9.942 | 0.0097 |
| 0.0 | 10.36 | 0.0101 |
| 5.0 | 11.9 | 0.0117 |
| 10.0 | 13.7 | 0.0134 |
| 15.0 | 16.0 | 0.0156 |
| 20.0 | 18.6 | 0.0181 |
| 25.0 | 21.6 | 0.0209 |
| 30.0 | 25.2 | 0.0243 |
| 40.0 | 34.6 | 0.0331 |
| 50.0 | 47.6 | 0.0450 |
| 60.0 | 64.4 | 0.0598 |
| 70.0 | 86.2 | 0.0785 |
| 80.0 | 115.0 | 0.1019 |
| 90.0 | 150.0 | 0.1294 |
| 100.0 | 197.0 | 0.1633 |

### Solubility of Mannitol in Water at Temperatures Above 100°. (Yokoda, 1929.)

| t° | Gms. $C_6H_{14}O_6$ per 100 gms. sat. sol. |
|---|---|
| 137.5 | 90 |
| 140 | 91 |
| 156 | 95 |
| 162.5 | 98.0 |
| 165 | 99.0 |

100 gms. sat. sol. of Mannitol in ordinary water ($H_2O$) contain 16.9 gms. $C_6H_{14}O_6$ at 19°.

100 gms. sat. sol. of Mannitol in heavy water ($D_2O$) contain 15.2 gms. $C_6H_{14}O_6$ at 19°. (Nachod, 1938.)

### Solubility of Mannitol in Aqueous Solutions of Boric Acid and Vice Versa at 25°. (Hermans, 1925.)

| Gms. per 100 gms. sat. sol. $HBO_2$ | Gms. per 100 gms. sat. sol. $C_6H_{14}O_6$ | Solid Phase |
|---|---|---|
| 0.0 | 17.7 | $C_6H_{14}O_6$ |
| 2.28 | 20.8 | " |
| 5.13 | 24.7 | " |
| 5.40 | 25.4 | " |
| 5.68 | 25.4 | " |
| 5.70 | 25.1 | " + $H_3BO_3$ |
| 5.52 | 22.5 | $H_3BO_3$ |
| 5.28 | 20.0 | " |
| 5.07 | 17.2 | " |
| 4.68 | 11.5 | " |
| 4.25 | 5.43 | " |

### Solubility of Mannitol in Aqueous Alcohol Solutions at Different Temperatures. (Creighton and Klauder, Jr, 1923.)

Constant agitation in a thermostat was employed and equilibrium was approached both from above and below. The m. pt. of the mannitol was 165°.9.

| t° | Gms. $CH_2OH(CHOH)_4CH_2OH$ per 100 gms. aq. Alcohol of 0.0 Wt. % $C_2H_5OH$ — $H_2O$. | 20 Wt. % $C_2H_5OH$. | 40 Wt. % $C_2H_5OH$. | 60 Wt. % $C_2H_5OH$. | 80 Wt. % $C_2H_5OH$. | 100 Wt. % $C_2H_5OH$. |
|---|---|---|---|---|---|---|
| 0 | 10.2 | 4.83 | 1.81 | 0.79 | 0.16 | 0.003 |
| 15 | 16.4 | 8.53 | 3.49 | 1.33 | 0.25 | 0.010 |
| 25 | 21.3 | 11.69 | 5.48 | 2.25 | 0.55 | 0.030 |
| 35 | 29.6 | 16.74 | 8.60 | 3.62 | 0.80 | 0.075 |
| 50 | 47.2 | 30.18 | 16.76 | 6.92 | 1.58 | 0.28 |
| 60 | 61.14 | 41.23 | 26.50 | 12.36 | 4.08 | 0.81 |

d-MANNITOL $CH_2OH(CHOH)_4CH_2OH$.

## Solubility of d Mannitol in Several Solvents.

(Upson, Fluevog and Albert, 1935.)

The determinations were made by observing the temperatures at which the last crystal disappeared from mixtures of known amounts of solid and solvent contained in 3 to 15 cc sealed glass bulbs while being slowly heated

Results for the solubility in:

Methyl alcohol

| t° | Gm. Mols. $C_6H_{14}O_6$ per 100 gm. mols. $CH_3OH$ |
|---|---|
| 47.0 | 0.0766 |
| 49.7 | 0.0874 |
| 60.8 | 0.136 |
| 66.0 | 0.173 |
| 69.7 | 0.210 |
| 72.9 | 0.256 |
| 77.3 | 0.316 |
| 80.5 | 0.367 |

Ethyl alcohol

| t° | Gm. Mols. $C_6H_{14}O_6$ per 100 gm. mols. $C_2H_5OH$ |
|---|---|
| 53.6 | 0.0293 |
| 62.0 | 0.0463 |
| 69.6 | 0.0634 |
| 73.0 | 0.0768 |
| 77.2 | 0.0989 |
| 80.3 | 0.122 |
| 85.2 | 0.166 |
| 92.5 | 0.255 |

Normal Propyl alcohol

| t° | Gm. Mols. $C_6H_{14}O_6$ per per 100 gm. mols. $C_3H_7OH$ |
|---|---|
| 58.8 | 0.0193 |
| 61.5 | 0.0236 |
| 67.3 | 0.0328 |
| 73.7 | 0.0474 |
| 78.6 | 0.0631 |
| 89.2 | 0.108 |
| 90.9 | 0.122 |
| 97.7 | 0.174 |

Iso Propyl alcohol

| t° | Gm. Mols. $C_6H_{14}O_6$ per 100 gm. mols. $C_3H_7OH$ |
|---|---|
| 55.2 | 0.0180 |
| 59.5 | 0.0224 |
| 65.7 | 0.0318 |
| 69.5 | 0.0459 |
| 79.3 | 0.0775 |
| 81.5 | 0.0882 |

Normal Butyl alcohol

| t° | Gm. Mols. $C_6H_{14}O_6$ per 100 gm. mols. $C_4H_9OH$ |
|---|---|
| 58.5 | 0.0131 |
| 65.8 | 0.0199 |
| 67.1 | 0.0207 |
| 77.0 | 0.0407 |
| 84.2 | 0.0648 |
| 89.4 | 0.0887 |
| 95.2 | 0.1337 |

Iso Butyl alcohol

| t° | Gm. Mols. $C_6H_{14}O_6$ per 100 gm. mols. $C_4H_9OH$ |
|---|---|
| 57.5 | 0.0110 |
| 61.3 | 0.0149 |
| 67.4 | 0.0195 |
| 73.6 | 0.0300 |
| 83.3 | 0.0538 |
| 89.5 | 0.0754 |
| 101.8 | 0.1636 |

Secondary Butyl alcohol

| t° | Gm. Mols. $C_6H_{14}O_6$ per 100 gm. mols. $C_4H_9OH$ |
|---|---|
| 53.5 | 0.0164 |
| 60.3 | 0.0227 |
| 66.1 | 0.0286 |
| 69.5 | 0.0356 |
| 73.0 | 0.0432 |
| 83.3 | 0.0772 |
| 100.8 | 0.1904 |

Tertiary Butyl aloohol

| t° | Gm. Mols. $C_6H_{14}O_6$ per 100 gm. mols. $C_4H_9OH$ |
|---|---|
| 43.1 | 0.0203 |
| 46.3 | 0.0250 |
| 55.0 | 0.0391 |
| 62.7 | 0.0574 |
| 71.5 | 0.0845 |
| 79.7 | 0.1115 |
| 90.3 | 0.1487 |

Allyl alcohol

| t° | Gm. Mols. $C_6H_{14}O_6$ per 100 gm. mols. $C_3H_5OH$ |
|---|---|
| 55.9 | 0.0296 |
| 59.4 | 0.0352 |
| 63.6 | 0.0460 |
| 69.3 | 0.0627 |
| 75.0 | 0.0854 |
| 79.7 | 0.112 |
| 84.7 | 0.141 |

100 gms. alcohol, Sp. Gr. 0.905, dissolve 1.56 gms. mannitol at 14°. (Krusemann, 1876.)

Data for the solubility of mannitol at high pressures are given by Cohen, Inouye and Euwen, 1910.

100 gms. sat. sol. in pyridine contain 0.47 gm. mannitol at 26°. (Holty, 1905.)

100 gms. aq. 50% pyridine dissolve 2.46 gms. mannitol at 20–25°. (Dehn, 1917.)

Data for the ternary systems mannitol + succinic acid nitrile + water and mannitol + triethylamine + water, are given by Timmermans, 1907.

$C_6H_{14}O_6$

## MANNITOL

Freezing-point data are given for mixtures of:

Mannitol + Antipyrine (Pfeiffer and Seydel, 1928.)
" + Sarcosine anhydride (Pfeiffer and Seydel, 1928.)
" + Erythritol (Puschin and Dezelic, 1932.)
" + Palmitic acid " " " "
" + Stearic acid " " " "

## SORBITOL etc. (Hexites) $C_6H_{14}O_6 \cdot \frac{1}{2}H_2O$

### Solubility of the Benzalic Compounds of Some Polyatomic Alcohols at 16°–18°.

(de Bruyn and van Ekenstein, 1899.)

No details of the determinations are given. It is stated that the results are sufficiently exact for use in identifying hexites.

| Name of Compound. | M.-pt. | | Gms. Compd. Dissolved per 100 cc. Sat. Sol. in: Acetone. | Chloroform. | Alcohol. |
|---|---|---|---|---|---|
| Dibenzalerythritol | 201 | (Fischer) | 0.34 | 3.64 | 0.02 |
| Monobenzalarabitol | 152 | " | ... | ... | ... |
| Dibenzaladonitol | 165 | " | 0.64 | 1.36 | 0.14 |
| Dibenzalxylitol | 175 | " | 1.10 | 0.85 | ... |
| Dibenzalrhamnitol | 203 | " | 0.70 | 2.55 | 1.10 |
| Monobenzal-*d*-Sorbitol | 175 | (Meunier) | very easily soluble | | |
| Dibenzal-*d*-Sorbitol | 163 | " | 5.44 | 0.16 | 0.10 |
| Tribenzalmannitol | 213–8 | (Fischer) | 0.42 | 8.75 | 0.10 |
| Tribenzal-*l*-iditol* | 215–8 | " | 0.47 | 0.17 | 0.05 |
| Tribenzal-*d*-talitol† | 210 | " | 0.30 | 4.42 | trace |
| Dibenzaldulcitol | 215–20 | " | 0.42 | 0.83 | trace |
| Dibenzalperseitol | 230–5 | " | 0.04 | trace | 0.02 |

* Prepared from *l* idonic acid. † Prepared from *d* talonic acid.

## HEXYL AMINE $n\,CH_3(CH_2)_4CH_2NH_2$.

### Distribution of *n* Hexyl Amine Between Water and Xylene at 25°.

(Smith, 1921, 1922.)

| Millimols. per liter $H_2O$ layer ($C_1$). | Millimols. per liter $C_6H_4(CH_3)_2$ layer ($C_2$). | $\frac{C_2}{C_1}$. | Millimols. per liter $H_2O$ layer ($C_1$). | Millimols. per liter $C_6H_4(CH_3)_2$ layer ($C_2$). | $\frac{C_2}{C_1}$. |
|---|---|---|---|---|---|
| 0.225 | 0.5875 | 2.61 | 0.7775 | 3.225 | 4.17 |
| 0.425 | 1.3375 | 3.14 | 1.50 | 8.50 | 5.65 |
| 0.625 | 2.325 | 3.88 | 2.80 | 17.2 | 6.15 |

## DiPROPYL AMINE $(C_3H_7)_2NH$.

### Distribution of Dipropyl Amine at 25° Between :

(Smith, 1921, 1922).

#### Water and Ether.

| Millimols. $(C_3H_7)_2NH$ per liter of $H_2O$ layer ($C_1$). | Millimols. $(C_3H_7)_2NH$ per liter of $(C_2H_5)_2O$ layer ($C_2$). | $\frac{C_2}{C_1}$. |
|---|---|---|
| 0.26 | 1.005 | 3.86 |
| 0.43 | 1.915 | 4.46 |
| 0.60 | 2.97 | 4.95 |
| 0.92 | 5.70 | 6.2 |
| 1.48 | 9.76 | 6.6 |

#### Water and Xylene.

| Millimols. $(C_3H_7)_2NH$ per liter of $H_2O$ layer ($C_1$). | Millimols. $(C_3H_7)_2NH$ per liter of Xylene layer ($C_2$). | $\frac{C_2}{C_1}$. |
|---|---|---|
| 0.323 | 1.04 | 3.19 |
| 0.456 | 1.544 | 3.38 |
| 0.575 | 2.325 | 4.04 |
| 0.85 | 4.16 | 4.88 |
| 1.45 | 8.55 | 5.90 |
| 2.42 | 17.58 | 7.25 |

#### Acetone and Glycerol.

| Millimols. $(C_3H_7)_2NH$ per liter of Acetone layer (A). | Millimols. $(C_3H_7)_2NH$ per liter of Glycerol layer (G). | $\frac{A}{G}$. |
|---|---|---|
| 1.30 | 0.925 | 1.40 |
| 1.925 | 1.325 | 1.45 |
| 3.85 | 1.60 | 2.40 |
| 5.425 | 2.025 | 2.69 |
| 8.775 | 2.275 | 3.64 |
| 10.1 | 2.75 | 3.67 |

DISTRIBUTION OF DIPROPYL AMINE BETWEEN WATER AND:
(Herz and Stanner, 1927.)

| Benzene | | | Toluene | | |
|---|---|---|---|---|---|
| Gm. Mols. $(C_3H_7)_2NH$ per liter | | 2 | Gm. Mols. $(C_3H_7)_2NH$ per liter | | 2 |
| $H_2O$ layer(1) | $C_6H_6$ layer(2) | 1 | $H_2O$ layer(1) | $C_6H_6$ $CH_3$ layer(2) | 1 |
| 0.0143 | 0.0755 | 5.29 | 0.0133 | 0.0653 | 4.92 |
| 0.0163 | 0.1237 | 7.57 | 0.0163 | 0.1286 | 7.87 |
| 0.0190 | 0.1898 | 10.00 | 0.0204 | 0.1829 | 8.96 |
| 0.0225 | 0.2571 | 11.45 | 0.0225 | 0.2347 | 10.45 |

DiPROPYL AMINE Acid Phthalate.

TriPROPYL AMINE Acid Phthalate.

DISTRIBUTION OF EACH SEPARATELY AT 25° BETWEEN ACETONE AND GLYCEROL
(Smith, 1921, 1922).

See Note under dimethyl amine acid phthalate, page 213.

Results for Dipropyl Amine Acid Phthalate

| Millimols. acid phthalate per liter of | | $\frac{A}{G}$. |
|---|---|---|
| Acetone layer (A). | Glycerol layer (G). | |
| 0.600 | 1.45 | 0.413 |
| 0.8875 | 2.50 | 0.335 |
| 1.35 | 4.525 | 0.298 |
| 1.895 | 7.625 | 0.239 |
| 2.45 | 10.90 | 0.224 |

Results for Tripropyl Amine Acid Phthalate.

| Millimols. acid phthalate per liter of | | $\frac{A}{G}$. |
|---|---|---|
| Acetone layer (A). | Glycerol layer (G). | |
| 1.400 | 1.375 | 1.020 |
| 2.125 | 2.55 | 0.843 |
| 3.125 | 4.45 | 0.702 |
| 4.25 | 6.80 | 0.625 |

Triethyl SULFONIUM IODIDE $S(C_2H_5)_3I$.

100 gms. $H_2O$ dissolve 431 gms. $S(C_2H_5)_3I$ at 25°. (Peddle and Turner, 1913.)
100 gms. $CHCl_3$ dissolve 47.7 gms. $S(C_2H_5)_3I$ at 25°. (Peddle and Turner, 1913.)

Triethyl PHOSPHINE SULFIDE $(C_2H_5)_3PS$

Freezing-point data for mixtures of tri ethyl phosphine sulfide and triphenyl phosphine sulfide are given by Pascal, 1923.

Triethyl AMINE $N(C_2H_5)_3$.

SOLUBILITY IN WATER.*
(Rothmund, 1898.)

| t°. | Gms. $N(C_2H_5)_3$ per 100 Gms. | | t°. | Gms. $N(C_2H_5)_3$ per 100 Gms. | |
|---|---|---|---|---|---|
| | Aq. Layer. | Amine Layer. | | Aq. Layer. | Amine Layer |
| 18.6 (crit. temp.) | 51.9 | | 40 | 3.65 | 96.48 |
| 20 | 14.24 | 72 | 50 | 2.87 | 96.4 |
| 25 | 7.30 | 95.18 | 55 | 2.57 | 96.3 |
| 30 | 5.80 | 96.60 | 60 | 2.23 | 96.3 |
| 35 | 4.58 | 96.5 | 65 | 1.97 | 96.3 |

* Determinations made by "Synthetic Method," see Note, p. 292.

The lower critical solution temperature of a 34.0 percent solution of tri ethyl amine in ordinary water($H_2O$) is 18.25°. (Timmermans and Hennaut-Roland, 1932.) The lower critical solution temperature of a 35.1 percent solution of tri ethyl amine in heavy water($D_2O$) is 14.4°. The former increases 0.02° for each additional kilogram of pressure and the latter 0.023° for each additional kilogram of pressure between 10 and 70 kilograms. (Timmermans and Poppe, 1935.)

$C_6H_{15}$

Freezing-point data for mixtures of tri ethyl amine and water are given by Guthrie, 1884, and Pickering, 1893. Data for the solubility of tri ethyl amine in water at high pressures are given by Kohnstamm and Timmermans, 1913.

### Solubility of Triethylamine in Water and in Aq. Ethyl Alcohol at Different Temperatures.*

(Meerburg, 1902.)

| Water. | | 13.33% Alcohol. | | 28.98% Alcohol. | | 38.84% Alcohol. | | 60.16% Alcohol. | |
|---|---|---|---|---|---|---|---|---|---|
| t°. | Gm. $N(C_2H_5)_3$ per 100 Gms. Sol. | t°. | Gm. $N(C_2H_5)_3$ per 100 Gms. Sol. | t°. | Gm. $N(C_2H_5)_3$ per 100 Gms. Sol. | t°. | Gm. $N(C_2H_5)_3$ per 100 Gms. Sol. | t°. | Gm. $N(C_2H_5)$ per 100 Gms. Sol. |
| 69.2 | 1.7 | 38.3 | 8.2 | 54.5 | 22.8 | 73.4 | 31.2 | 76–77 | 71.2 |
| 30.8 | 5.6 | 31.7 | 13.9 | 45 | 29.8 | 65.4 | 33.3 | 74–75 | 75 |
| 23.1 | 8.5 | 28 | 21.6 | 33.4 | 51.1 | 51.6 | 40.6 | 72–73 | 80 |
| 18.7 | 25.8 | 26.4 | 30.6 | 31.4 | 63.7 | 42.1 | 50.6 | | |
| 18.7 | 37.2 | 24.9 | 40.5 | 30.3 | 68.5 | 40.9 | 54.7 | | |
| 19.5 | 51.8 | 24.2 | 49.8 | 28.5 | 82.2 | 34.2 | 70.6 | | |
| 20.5 | 68.6 | 24.1 | 60.7 | 35 | 91.8 | 33 | 77.5 | | |
| 20.5 | 84 | 24 | 69.7 | | | 34.7 | 88 | | |
| 20.5 | 89.7 | 23.5 | 76.6 | | | 40.5 | 91.3 | | |
| 21.2 | 92.4 | 24 | 81.5 | | | | | | |
| 25.8 | 95.5 | 24.2 | 87.4 | | | | | | |
| 26.5 | 96.1 | 25 | 92 | | | | | | |

Note. — Results for triethylamine, water and ethyl ether, and for triethylamine, water and phenol are also given by Meerburg.

100 gms. abs. methyl alcohol dissolve 57.5 gms. $NH(C_6H_5)_2$ at 19.5°.
100 gms. abs. ethyl alcohol dissolve 56 gms. $NH(C_6H_5)_2$ at 19.5°.

(de Bruyn, 1892.)

* Determinations made by "Synthetic Method," see Note, p. 282

Data for ternary systems composed of triethylamine, water and each of the following compounds: naphthalene, cane sugar, KCl, $K_2CO_3$, $K_2SO_4$ and KSCN, are given by Timmermans (1907).

### Distribution of Triethyl Amine at 25° Between: (Smith, 1921-1922.)

Water and Chloroform.

| Millimols. $(C_2H_5)_3N$ | | |
|---|---|---|
| $H_2O$ layer ($C_1$). | $CHCl_3$ layer ($C_2$) | $\frac{C_2}{C_1}$. |
| 0.0375 | 0.490 | 13.0 |
| 0.0516 | 0.800 | 15.5 |
| 0.194 | 3.806 | 19.7 |
| 0.425 | 9.575 | 22.5 |

Water and Xylene.

| Millimols. $(C_2H_5)_3N$ | | |
|---|---|---|
| $H_2O$ layer ($C_1$). | $C_6H_4(CH_3)_2$ layer ($C_2$). | $\frac{C_2}{C_1}$. |
| 0.3125 | 0.9875 | 3.16 |
| 0.625 | 2.475 | 3.96 |
| 0.80 | 3.60 | 4.50 |
| 1.49 | 8.51 | 5.72 |
| 2.53 | 17.47 | 6.90 |

Acetone and Glycerol.

| Millimols. $(C_2H_5)_3N$ | | |
|---|---|---|
| Acetone layer (A). | Glycerol layer (G). | $\frac{A}{G}$. |
| 1.470 | 0.865 | 1.70 |
| 2.875 | 1.175 | 2.44 |
| 6.35 | 1.65 | 3.85 |
| 13.20 | 2.25 | 5.87 |
| 25.80 | 3.20 | 8.06 |

### Distribution at 25° of: (Smith, 1921-1922.)

Diethyl Amine Acid Phthalate (See Note p. 213) Between Acetone and Glycerol.

| Millimols. per liter | | |
|---|---|---|
| Acetone layer (A). | Glycerol layer (G). | $\frac{A}{G}$. |
| 0.450 | 2.0375 | 0.221 |
| 0.775 | 4.15 | 0.187 |
| 1.05 | 6.65 | 0.158 |
| 1.325 | 9.975 | 0.133 |
| 1.65 | 12.80 | 0.129 |

Triethyl Amine Acid Phthalate (See Note p. 213.)

| Millimols. per liter | | |
|---|---|---|
| Acetone layer (A). | Glycerol layer (G). | $\frac{A}{G}$. |
| 0.70 | 2.35 | 0.298 |
| 1.10 | 4.075 | 0.270 |
| 1.45 | 5.60 | 0.259 |
| 2.00 | 9.35 | 0.214 |
| 2.70 | 12.775 | 0.2115 |

Ethyl Phenyl Amine Between Water and Xylene.

| Millimols. per liter | | |
|---|---|---|
| $H_2O$ layer ($C_1$) | $C_6H_4(CH_3)_2$ layer ($C_2$) | $\frac{C_2}{C_1}$ |
| 0.1940 | 0.582 | 3.00 |
| 0.2380 | 0.763 | 3.20 |
| 0.3437 | 1.13 | 3.29 |
| 0.4125 | 1.51 | 3.64 |

### Distribution of Tri ethyl Amine Between Water and Amyl Alcohol at 25°.

(Herz and Fischer, 1904.)

| Gms. $(C_2H_5)_3N$ per liter | | Gm. Mols. $(C_2H_5)_3$ N per liter | |
|---|---|---|---|
| $H_2O$ layer | Alcohol layer | $H_2O$ layer | Alcohol layer |
| 0.885 | 22.99 | 0.00875 | 0.2273 |
| 1.683 | 44.57 | 0.01664 | 0.4408 |
| 1.866 | 49.22 | 0.01846 | 0.4868 |
| 2.502 | 64.91 | 0.02474 | 0.6418 |

### Distribution of Triethyl Amine at 25° Between:

(Kolossowski and Androshenko, 1934.)

| Water and Benzene | | | Water and Toluene | | |
|---|---|---|---|---|---|
| Gm. Mols. $(C_2H_5)_3N$ per liter | | 1 | Gm. Mols. $(C_2H_5)_3N$ per liter | | 1 |
| $H_2O$ layer(1) | $C_6H_6$ layer(2) | 2 | $H_2O$ layer(1) | $C_6H_5CH_3$ layer(2) | 2 |
| 0.0156 | 0.1794 | 0.087 | 0.0046 | 0.0239 | 0.14 |
| 0.0200 | 0.2356 | 0.085 | 0.0069 | 0.0579 | 0.12 |
| 0.0417 | 0.5280 | 0.079 | 0.0096 | 0.0792 | 0.12 |
| 0.0762 | 1.1233 | 0.068 | 0.1042 | 1.0804 | 0.10 |
| 0.1221 | 1.9211 | 0.064 | 0.1518 | 1.7390 | 0.09 |
| 0.2152 | 3.3049 | 0.065 | 0.2941 | 4.5160 | 0.065 |
| 0.2781 | 4.7167 | 0.059 | 0.3577 | 5.5340 | 0.065 |

### Distribution of Triethyl Amine Between Water and Toluene.

(Moore and Winmill, 1918.)

| t° | Gm. Equiv. $(C_2H_5)_3N$ per liter aq. layer | Dist. Coef. |
|---|---|---|
| 18 | 0.0190 | 0.131 |
| 25 | 0.0104 | 0.099 |
| 25 | 0.0131 | 0.099 |
| 32.35 | 0.0132 | 0.069 |

Similar data at other temperatures are given by Hantzsch and Sebaldt, 1899; and Hantzsch and Vagt, 1901.

Results for the total and partial vapor pressures at 20.5° of mixture of tri ethyl amine and methyl alcohol and of tri ethyl amine and ethyl ether are given by Joukovsky, 1934.

Freezing-point data for mixtures of tri ethyl amine and each of the following compounds: benzene, nitro benzene, formic acid and carbon disulfide, are given by Joukovsky, 1934.

## TRI ETHYL AMINE HBr, HCl and HI

### Solubility of Each Separately in Water and in Chloroform.

(Peddle and Turner, 1913.)

| Compound | Formula | Gms. compound per 100 gms. $H_2O$ | Gms. compound per 100 gms. $CHCl_3$ |
|---|---|---|---|
| Tri ethyl amine Hydrobromide | $(C_2H_5)_3N.HBr$ | 150.6 | 23.44 |
| " " " Hydrochloride | $(C_2H_5)_3N.HCl$ | 137.0 | 17.37 |
| " " " Hydriodide | $(C_2H_5)_3N.HI$ | 370.0 | 92.2 |

**PENTA BROMO TOLUENE** $C_6Br_5CH_3$.

100 cc Methyl Alcohol (d = 0.7975) dissolve 0.0108 gm. $C_6Br_5CH_3$ at 20°.
" " Ethyl " (96%) " 0.0104 " " " "
(Schulz, 1929.)

**NITRO DICHLORO BENZOIC ACID** (5) $NO_2(2,4)Cl_2C_6H_2COOH$.

Freezing-point data for mixtures of 5 nitro 2.4 dichloro benzoic acid and 5 nitro, 4-oxy, 2-chloro benzoic acid are given by Grimm, Günther and Titus, 1931.

**TRI NITRO BENZOIC ACID** 1.2.4.6 $C_6H_2(NO_2)_3COOH$.

SOLUBILITY OF TRINITRO BENZOIC ACID IN WATER AND ORGANIC SOLVENTS AT 25°.
(Desvergnes, 1931.)

| Solvent | Gms. $C_6H_2(NO_2)_3COOH$ per 100 gms. solvent | Solvent | Gms. $C_6H_2(NO_2)_3COOH$ per 100 gms. solvent |
|---|---|---|---|
| $H_2O$ | 2.053 (23.5°) | $C_6H_6$ | 0.31 |
| " | 4.180 (50°) | $CHCl_3$ | 0.37 |
| $CH_3COOC_2H_5$ | 21.05 | $(C_2H_5)_2O$ | 14.07 |
| $(CH_3)_2CO$ | 22.12 | $CS_2$ | 0.14 |
| 96% $C_2H_5OH$ | 27.53 | $CCl_4$ | 0.07 |
| 100% " | 26.59 | $C_6H_5CH_3$ | 0.38 |
| $CH_3OH_3$ | 50.69 | | |

DISTRIBUTION OF TRINITRO BENZOIC ACID BETWEEN WATER AND ETHYL ETHER AT 25°.
(Smith, 1921-2)

| Gm. Mols. 1.2.4.6 $(NO_2)_3C_6H_2COOH$ per liter | | $\frac{2}{1}$ |
|---|---|---|
| $H_2O$ layer(1) | $(C_2H_5)_2O$ layer(2) | |
| 1.09 | 0.20 | 0.182 |
| 2.56 | 0.84 | 0.328 |
| 4.80 | 2.20 | 0.458 |
| 8.28 | 5.88 | 0.710 |

**NITRO PHENYL CHLOROFORM** $NO_2C_6H_4CCl_3$.

Freezing-point data for mixtures of o, m and p nitro phenyl, chloroform are given by Hollman, Vermeulen and de Mooy, 1914.)

Diiodo **SALYCILIC ACID** $I_2(3,5)C_6H_2COOH(1)OH(2)$.

One liter of water dissolves 0.166 gm. of the compound at 10° and 0.192 gm. at 25°.
(Cofman, 1920.)

**SULFO BENZOIC ACID CHLORIDE** $COCl.C_6H_4.SO_2Cl$.

Freezing-point data for mixtures of sulfo benzoic acid chlorides and benzene di sulfo chloride are given by Maarse, 1914.

## BROMO NITRO BENZOIC ACID $NO_2.Br.C_6H_3COOH$.

### Solubility of Nitrobromobenzoic Acids and of Nitrochlorobenzoic Acids in Water at 25°.

(Holleman, 1910.)

| Acid. | Gms. Acid per 100 cc. Sol. | Acid. | Gms. Acid per 100 cc. Sol. |
|---|---|---|---|
| $C_6H_3COOH.NO_2.Br$ 1.2.3 | 0.033 | $C_6H_3COOH.NO_2Cl$ 1.2.3 | 0.047 |
| $C_6H_3COOH.NO_2.Br$ 1.2.5 | 0.741 | $C_6H_3COOH.NO_2.Cl$ 1.2.5 | 0.967 |

Holleman also gives data for the solubility of various mixtures of the above two bromo compounds and of the two chloro compounds and uses the results for estimating the quantity of each in an unknown mixture.

## DI CHLORO BENZOIC ACIDS $Cl_2C_6H_3COOH$.

Freezing-point data are given for:

2.5 Dichloro benzoic acid + m chloro benzoic acid.
" " " " + 2.3 Dichloro benzoic acid.
(Hope and Riley, 1923.)

## CHELIDONIC ACID $C_7H_4O_6.H_2O$.

100 gms. sat. sol. of chelidonic acid in water contain 1.45 gms. $C_7H_4O_6$ at 25°. (Verkade, 1924.)

100 gms. sat. sol. of chelidonic acid in 0.5 molar aq. $H_3BO_3$ sol. contain 1.51 gms. $C_7H_4O_6$ at 25°. (Verkade, 1924.)

## DI NITRO BENZOIC ACID $3.5(NO_2)_2C_6H_3.COOH$.

### Solubility of 3.5 Dinitro Benzoic Acid in Aqueous Solutions of Hydrochloric Acid at 25°.

(Knox and Richards, 1919.)

| Gm. Equivalents per liter | |
|---|---|
| HCl | $(NO_2)_2C_6H_3COOH$ |
| 0.0 | 0.00635 |
| 1.565 | 0.00398 |
| 2.908 | 0.00470 |
| 4.594 | 0.00583 |
| 5.657 | 0.00690 |
| 7.336 | 0.00841 |
| 8.855 | 0.00965 |
| 10.27 | 0.01095 |
| 11.73 | 0.01240 |

## Dinitro BENZOIC ACIDS $C_6H_3(NO_2)_2COOH$. 1.3.5 and 1.2.4.

### Solubility of 3.5 and of 2.4 Dinitrobenzoic Acids in Aqueous Solutions of Sodium Acetate at 25°.

(Philip and Garner, 1909.)

| Gms. per 100 cc. Sat. Sol. | |
|---|---|
| $CH_3COONa$. | $3.5C_6H_3(NO_2)_2COOH$. |
| 0 | 0.1314 |
| 0.0976 | 0.3392 |
| 0.2428 | 0.6720 |
| 0.4846 | 1.201 |
| 0.9718 | 2.115 |

| Gms. per 100 cc. Sat. Sol. | |
|---|---|
| $CH_3COONa$. | $2.4C_6H_3(NO_2)_2COOH$. |
| 0 | 0.0572 |
| 0.0976 | 0.2056 |
| 0.2428 | 0.3434 |
| 0.4846 | 0.5023 |
| 0.9718 | 0.7440 |

Data for the solubility of 1.3.5 dinitrobenzoic acid in water and aqueous solutions of KCl, NaCl, $KNO_3$ and $NaNO_3$, and for its distribution between water and benzene at 25°, are given by B. de Szyszkowski (1915).

## Solubility of 1.3.5 Dinitrobenzoic Acid in Water at High Temperatures, Determined by the Synthetic Method.

(Flaschner and Rankin, 1910.)

| t°. | Gms. Acid per 100 Gms. Sol. | t°. | Gms. Acid per 100 Gms. Sol. | t°. | Gms. Acid per 100 Gms. Sol. |
|---|---|---|---|---|---|
| 123.8 crit. t. | ... | 123 | 66.5 | 160 | 90.9 |
| 113 | 4.4 | 125 | 72.7 | 180 | 95 |
| 120 | 9.3 | 130 | 79.3 | 200 | 99 |
| 121 | 14.5 | 140 | 85.7 | 206 | 100 |
| 122 | 40 | 150 | 89 | | |

## Solubility of 1.3.5 Dinitro Benzoic Acid in Aqueous Solutions of Salts at 25°.

(de Szyszkowski, 1914.)

| Normality of aq. salt solution. | Gm. mols. 1.3.5 $(NO_2)_2C_6H_3.COOH$ per 1000 gms. sat. solution in aqueous KCl | aqueous NaCl. | aqueous $KNO_3$. |
|---|---|---|---|
| 0.0 (= $H_2O$)..... | $6.168.10^{-3}$ | $6.168.10^{-3}$ | $6.344.10^{-3}$ |
| 0.033..... | 6.397 » | – | – |
| 0.05..... | 6.471 » | – | – |
| 0.10..... | 6.581 » | 6.412 » | – |
| 0.143..... | 6.546 » | – | |
| 0.25..... | 6.540 » | 6.305 » | 7.499 » |
| 0.50..... | 6.470 » | 6.161 » | 8.095 » |
| 1.00..... | 6.147 » | 5.389 » | 8.913 » |
| 1.75..... | – | – | 9.970 » |

## Solubility of 1.3.5 Dinitro Benzoic Acid at 25° in :

(de Szyszkowski, 1914.)

### Aqueous solutions of KCl in presence of $C_6H_6$.

| Normality of aq. KCl. | Gm. mols. 1.3.5 $(NO_2)_2C_6H_3.COOH$ per 1000 gms. sat. aq. sol. |
|---|---|
| 0.0 | $6.253.10^{-3}$ » |
| 0.1 | 6.62[illegible] » |
| 0.25 | 6.697 » |
| 0.50 | 6.589 » |
| 0.75 | 6.491 » |
| 1.00 | 6.323 » |
| 2.00 | 5.611 » |

### $C_6H_6$ in presence of aqueous solutions of KCl.

| Normality of aq. KCl in contact with $C_6H_6$. | Gm. mols. 1.3.5 $(NO_2)_2C_6H_3.COOH$ per 1000 gms. sat. sol. in $C_6H_6$. |
|---|---|
| 0.0 | $8.676.10^{-3}$ |
| 0.1 | 8.470 » |
| 0.25 | 8.447 » |
| 0.50 | 8.352 » |
| 0.75 | 8.390 » |
| 1.00 | 8.268 » |
| 2.00 | 8.085 » |

## Distribution of 1.3.5 Dinitro Benzoic Acid Between :

(de Szyszkowski, 1914.)

### Water and Benzene at 25°.

| Gm. mols. 1.3.5 $(NO_2)_2C_6H_3COOH$ per 1000 gms. | |
|---|---|
| $H_2O$ layer. | $C_6H_6$ layer. |
| $1.009.10^{-3}$ | $1.120.10^{-3}$ |
| 1.608 » | 1.982 » |
| 3.727 » | 4.686 » |
| 4.794 » | 6.473 » |
| 6.258 » | 8.676 »* |

### Water and Benzene at 40°.

| Gm. mols.* 1.3.5 $(NO_2)_2C_6H_3COOH$ per 1000 gms. | |
|---|---|
| $H_2O$ layer. | $C_6H_6$ layer. |
| $2.059.10^{-3}$ | $2.462.10^{-3}$ |
| 3.120 » | 3.925 » |
| 4.135 » | 5.393 » |
| 6.480 » | 9.630 » |
| 7.536 » | 11.610 » |
| 10.150 » | 17.940 » |

### Water and Chloroform at 25°.

| Gm. mols. 1.3.5 $(NO_2)_2C_6H_3COOH$ per 1000 gms. | |
|---|---|
| $H_2O$ layer. | $CHCl_3$ layer. |
| $1.245.10^{-3}$ | $0.658.10^{-3}$ |
| 1.835 » | 1.055 » |
| 3.367 » | 2.225 » |
| 5.237 » | 4.190 » |
| 6.273 » | 5.158 »* |

*Both layers were saturated with 1.3.5 Dinitro Benzoic Acid.

One liter of Benzene sat. with 1.3.5 Dinitro Benzene contains 0.00488 gm. mol. $(NO_2)_2\ C_6H_3COOH$ at 25°. (v. Szyszkowski, 1928.)

DISTRIBUTION OF 1.3.5 DINITRO BENZOIC ACID AT 25° BETWEEN : (Smith, 1921-1922.)

Water and Chloroform.

| Millimols. 1.3.5 $(NO_2)_2C_6H_3COOH$ per liter of $H_2O$ layer ($C_1$). | Millimols. 1.3.5 $(NO_2)_2C_6H_3COOH$ per liter of $CHCl_3$ layer ($C_2$). | $\frac{C_2}{C_1}$. |
|---|---|---|
| 1.450 | 0.975 | 0.672 |
| 1.992 | 1.425 | 0.715 |
| 2.855 | 2.38 | 0.834 |
| 4.04 | 3.71 | 0.918 |

Water and Ethyl Ether.

| Millimols. 1.3.5 $(NO_2)_2C_6H_3COOH$ per liter of $H_2O$ layer ($C_1$). | Millimols. 1.3.5 $(NO_2)_2C_6H_3COOH$ per liter of $(C_2H_5)_2O$ layer ($C_2$). | $\frac{C_2}{C_1}$. |
|---|---|---|
| 0.1325 | 1.0475 | 7.9 |
| 0.1850 | 1.815 | 9.8 |
| 0.225 | 2.655 | 11.8 |
| 0.295 | 3.885 | 13.2 |
| 0.365 | 6.395 | 17.5 |

Water and Xylene.

| Millimols. 1.3.5 $(NO_2)_2C_6H_3COOH$ per liter of $H_2O$ layer ($C_1$). | Millimols. 1.3.5 $(NO_2)_2C_6H_3COOH$ per liter of $C_6H(CH_3)_3$ layer ($C_2$). | $\frac{C_2}{C_1}$. |
|---|---|---|
| 1.53 | 1.11 | 0.72 |
| 2.40 | 2.10 | 0.875 |
| 3.15 | 2.95 | 0.936 |
| 4.05 | 4.50 | 1.11 |

DISTRIBUTION OF 1.2.4 DINITRO BENZOIC ACID AT 25° BETWEEN : (Smith, 1921-1922.)

Water and Chloroform.

| Millimols. 1.2.4 $(NO_2)_2C_6H_3CO\,OH$ per liter of $H_2O$ layer ($C_1$). | Millimols. 1.2.4 $(NO_2)_2C_6H_3CO\,OH$ per liter of $CHCl_3$ layer ($C_2$). | $\frac{C_2}{C_1}$. |
|---|---|---|
| 6.78 | 0.40 | 0.059 |
| 7.85 | 0.55 | 0.070 |
| 8.65 | 0.70 | 0.0815 |
| 10.95 | 1.10 | 0.100 |

Water and Ethyl Ether.

| Millimols. 1.2.4 $(NO_2)_2C_6H_3CO\,OH$ per liter of $H_2O$ layer ($C_1$). | Millimols. 1.2.4 $(NO_2)_2C_6H_3CO\,OH$ per liter of $(C_2H_5)_2O$ layer ($C_2$). | $\frac{C_2}{C_1}$. |
|---|---|---|
| 0.67 | 0.68 | 0.91 |
| 1.15 | 1.69 | 1.41 |
| 1.45 | 2.51 | 1.73 |
| 1.79 | 4.08 | 2.28 |
| 2.495 | 7.78 | 3.12 |

Water and Xylene.

| Millimols. 1.2.4 $(NO_2)_2C_6H_3CO\,OH$ per liter of $H_2O$ layer ($C_1$). | Millimols. 1.2.4 $(NO_2)_2C_6H_3CO\,OH$ per liter of $C_6H_3(CH_3)_3$ layer ($C_2$). | $\frac{C_2}{C_1}$. |
|---|---|---|
| 6.78 | 0.40 | 0.059 |
| 7.85 | 0.55 | 0.070 |
| 8.60 | 0.70 | 0.0815 |
| 10.95 | 1.10 | 0.100 |

## Dinitro *p* oxy**BENZOIC ACID** $C_6H_2OH(NO_2)_2COOH$.

SOLUBILITY OF MIXTURES OF DINITRO PARA OXYBENZOIC ACID AND OTHER COMPOUNDS IN ABSOLUTE ETHYL ALCOHOL AT 29.6°.

(Morgenstern, 1911.)

Dinitro *p* Oxybenzoic Acid + Phenanthrene.

| Gms. per 100 gms. Sat. Sol. Acid. | Gms. per 100 gms. Sat. Sol. Phenanthrene. | Solid Phase. |
|---|---|---|
| 2.0483 | 0.1333 | Acid |
| 2.0776 | 0.2796 | " |
| 2.1249 | 0.5267 | " |
| 2.2195 | 1.0311 | " |
| 2.2883 | 1.4310 | " |
| 1.2171 | 6.0092 | Phenanthrene |
| 0.8681 | 5.8300 | " |
| 0.6017 | 5.6890 | " |
| 0.3487 | 5.5619 | " |
| 0.2157 | 5.4890 | " |
| 0 | 5.3781 | " |

Dinitro *p* Oxybenzoic Acid + Fluorene.

| Gms. per 100 Gms. Sat. Sol. Acid. | Gms. per 100 Gms. Sat. Sol. Fluorene. | Solid Phase. |
|---|---|---|
| 2.0440 | 0.1232 | Acid |
| 2.0823 | 0.3484 | " |
| 2.1045 | 0.4824 | " |
| 2.1744 | 0.8960 | " |
| 2.2618 | 1.4308 | " |
| 1.0490 | 3.8618 | Fluorene |
| 0.8004 | 3.7566 | " |
| 0.5620 | 3.6532 | " |
| 0.3900 | 3.5811 | " |
| 0.2113 | 3.5024 | " |
| 0 | 3.4115 | " |

Dinitro *p* Oxybenzoic Acid + Retene.

| Gms. per 100 Gms. Sat. Sol. Acid. | Gms. per 100 Gms. Sat. Sol. Retene. | Solid Phase. |
|---|---|---|
| 2.0232 | 0 | Acid |
| 2.0484 | 0.1236 | " |
| 2.0933 | 0.3446 | " |
| 2.1276 | 0.5162 | " |
| 2.2346 | 1.0489 | " |
| 2.3034 | 1.3634 | " |
| 1.9664 | 3.3698 | Retene |
| 0.7830 | 3.0032 | " |
| 0.5597 | 2.9331 | " |
| 0.2740 | 2.8466 | " |
| 0 | 2.2795 | " |

## MECONIC ACID $C_7H_4O_7.3H_2O$.

100 cc. sat. sol. of { Water contain 0.84 gm. $C_7H_4O_7$ at 25°.
Meconic acid in { Aq. 0.5 mol. $H_3BO_3$ solution contain 1.0 gm. $C_7H_4O_7$ at 25°. (Verkade, 1924.)

**TRI BROMO TOLUENES** $Br_3C_6H_2CH_3$.

Freezing-point data for binary mixtures of isomeric tri bromo toluenes are given by Jaeger, 1904.

**CYAN BENZENE** $C_6H_5CN$.

Freezing-point data for mixtures of cyan benzene and chloro benzene are given by Pascal, 1913.

**2-BENZO THIAZOLE THIOL** $C_6H_4SC(SH):N$.

Freezing-point data for mixtures of:

2-Benzo Thiazole thiol + Methylene aniline (Kojima and Nagai, 1931.)
" " " + Diphenyl guanidine (Minotoya, Kojima and Nagai, 1931.)

**BENZOYL CHLORIDE** $C_6H_5COCl$.

Freezing-point data for mixtures of benzoyl chloride and phenol are given by Tsakalotos and Guye, 1910.

**NITRO BENZOIC ALDEHYDE** m $(NO_2)C_6H_4CHO$.

Freezing-point data for mixtures of nitro benzoic aldehyde and benzoic acid are given by Passernii, 1924.

Brom, Chlor and Iodo**BENZOIC ACIDS.**

SOLUBILITY IN WATER AT 25°. (Paul, 1894; Löwenherz, 1898; Vaubel, 1895.)

| Compound. | Formula. | Per 1000 cc. Aqueous Solution. Grams. | Gram Mol. |
|---|---|---|---|
| Brombenzoic Acid | $C_6H_4Br.COOH$ (ortho) | 1.856 | 0.00924 |
| Brombenzoic Acid | $C_6H_4Br.COOH$ (meta) | 0.402 | 0.00200 |
| Brombenzoic Acid | $C_6H_4Br.COOH$ (para) | 0.056 | 0.00028 |
| Chlorbenzoic Acid | $C_6H_4Cl.COOH$ (ortho) | 2.087 | 0.01333 |
| Iodobenzoic Acid | $C_6H_4I.COOH$ (ortho) | 0.952 | 0.00384 |
| Iodobenzoic Acid | $C_6H_4I.COOH$ (meta) | 0.116 | 0.00047 |
| Iodobenzoic Acid | $C_6H_4I.COOH$ (para) | 0.027 | (Kodpal, 1912.) |

The following results at 28°. (Sieger, 1912.)

| | | | | |
|---|---|---|---|---|
| Chlorobenzoic acid | $C_6H_4ClCOOH$ | (ortho) | 2.25 | ... |
| " | " | (meta) | 0.45 | ... |
| " | " | (para) | 0.093 | ... |

MUTUAL SOLUBILITY OF BROMO AND CHLOROBENZOIC ACIDS AND WATER AT HIGH TEMPERATURES, DETERMINED BY SYNTHETIC METHOD. (Flaschner and Rankin, 1910.)

| *p* Bromobenzoic Acid + Water. | | *o* Chlorobenzoic Acid + Water. | | *m* Chlorobenzoic Acid + Water. | | *p* Chlorobenzoic Acid + Water. | |
|---|---|---|---|---|---|---|---|
| t° of Melting. | Gms. Acid per 100 Gms. Mixture. | t° of Melting. | Gms. Acid per 100 Gms. Mixture. | t° of Melting. | Gms. Acid per 100 Gms. Mixture. | t° of Melting. | Gms. Acid per 100 Gms. Mixture. |
| 170 (Crit. sol. temp.) | | 100.8 | 5.5 | 123 | 4.2 | 167 (crit. t.) | |
| 169 | 3 | 102.7 | 10 | 123.8 | 18.9 | 162 | 3 |
| 180 | 6.2 | 104 | 20 | 142.8 (crit. t.) | 34.3 | 170 | 5.4 |
| 190 | 10.5 | 126.2 (crit. t.) | 34.9 | 123.8 | 75.8 | 180 | 10 |
| 196 | 27 | 104 | 76 | 125 | 81.5 | 183 | 14.5 |
| 200 | 61 | 110 | 85.3 | 130 | 87.5 | 184 | 21.5 |
| 210 | 80 | 120 | 92 | 140 | 93.2 | 187 | 47 |
| 220 | 88.3 | 130 | 96.5 | 150 | 97.5 | 200 | 79.5 |
| 240 | 96.9 | 139.5 | 100 | 156 | 100 | 220 | 92 |
| 254 | 100 | | | | | 240 | 100 |

### Distribution of o Bromo Benzoic Acid at 25° Between Water and Chloroform.

(Smith and White, 1929.)

| Gm. Mols. o Br $C_6H_4COOH$ per liter | | Gm. Mols. o Br $C_6H_4COOH$ per liter | |
|---|---|---|---|
| $H_2O$ layer(1) | $CHCl_3$ layer(2) | $H_2O$ layer(1) | $CHCl_3$ layer(2) |
| 0.00290 | 0.0205 | 0.00422 | 0.0422 |
| 0.00343 | 0.0282 | 0.00455 | 0.0493 |
| 0.00390 | 0.0365 | 0.00489 | 0.0567 |

## Chloro BENZOIC ACIDS o, m and p $Cl.C_6H_4.COOH$.

### Solubility of Chloro Benzoic Acids in Water at 25°.

| Acid | Gms. $Cl.C_6H_4COOH$ per liter | |
|---|---|---|
| Ortho Chloro Benzoic Acid | 2.13(1) | 2.08(2) |
| Meta " " " | 0.385 | 0.41 |
| Para " " " | 0.068 | 0.077 |

(1) Osol and Kilpatrick, 1933; (2) Reyer, 1923.

1000 gms. $H_2O$ dissolve approx. 0.04 gm. p $Cl.C_6H_4.COOH$ (Microbic Acid). (Otto, 1917, 1925.)

### Solubility of Chloro Benzoic Acids in Aqueous Potassium Chloride Solutions at 25°.

(Osol and Kilpatrick, 1933.)

The experiments are concerned with the relation of the activity coefficients of the molecules of chloro benzoic acids and the "salting out" or "salting in" effect in aqueous salt solutions. In order to minimize the correction for the part present as ions, buffer solutions were used in all cases. These are characterized only in terms of molar concentrations of sodium salt.

Results for:

| Gm. Mols. KCl per liter in each case | o Chloro benzoic acid in 0.01 molar sodium salt | | m Chloro benzoic acid in 0.00212 molar sodium salt | | p Chloro benzoic acid in 0.000342 molar sodium salt | |
|---|---|---|---|---|---|---|
| | d. of sat. sol. | Total gm. mol. o $ClC_6H_4COOH$ per liter | d. of sat. sol. | Total gm. mol. m $ClC_6H_4COOH$ per liter | d. of sat. sol. | Total gm. mol. p $ClC_6H_4COOH$ per liter |
| 0.1 | 1.002 | 0.01137 | — | — | — | — |
| 0.2 | — | — | 1.007 | 0.00199 | — | — |
| 0.3 | 1.012 | 0.01086 | — | — | — | — |
| 0.5 | 1.021 | 0.01014 | 1.020 | 0.00183 | 1.020 | 0.000331 |
| 0.75 | — | — | 1.031 | 0.00167 | — | — |
| 1.0 | 1.042 | 0.00861 | 1.042 | 0.00158 | 1.041 | 0.000273 |
| 1.5 | — | — | 1.064 | 0.00127 | 1.063 | 0.000235 |
| 2.0 | 1.087 | 0.00607 | — | — | 1.086 | 0.000206 |
| 2.5 | — | — | — | — | 1.107 | 0.000156 |

Results similar to the above are given for aqueous solutions of NaCl, LiCl, KBr, $NaClO_4$, CsCl, sodium chloro benzoates, sodium benzene sulfonate, sodium toluene sulfonate and Sodium β naphthalene sulfonate.

SOLUBILITY OF ORTHOCHLOROBENZOIC ACID IN AQ. SOLUTIONS OF SODIUM ACETATE, SODIUM FORMATE AND POTASSIUM FORMATE AT 25°. (Philip and Garner, 1909.)

| In Aq. $CH_3COONa$. Grams per Liter. | | In Aq. HCOONa. Grams per Liter. | | In Aq. HCOOK. Grams per Liter. | |
|---|---|---|---|---|---|
| $CH_3COONa$. | $C_6H_4ClCOOH$. | HCOONa. | $C_6H_4ClCOOH$. | HCOOK. | $C_6H_4ClCOOH$. |
| 1.009 | 3.599 | 0.843 | 3.381 | 0 | 2.128 |
| 2.484 | 6.181 | 2.102 | 5.258 | 1.025 | 3.396 |
| 5.027 | 15.60 | 4.196 | 7.637 | 2.563 | 5.226 |
| 10.07 | 18.27 | 8.410 | 11.02 | 5.124 | 7.543 |

DISTRIBUTION OF ORTHO CHLORO BENZOIC ACID AT 25° BETWEEN:
(Smith and White, 1929.)

Water and Chloroform

| Gm. mols. o $ClC_6H_4COOH$ per liter | |
|---|---|
| $H_2O$ layer | $CHCl_3$ layer |
| 0.00231 | 0.0108 |
| 0.00290 | 0.0152 |
| 0.0317 | 0.0176 |
| 0.0357 | 0.0207 |
| 0.0403 | 0.0264 |
| 0.0502 | 0.0365 |

Water and Toluene

| Gm. mols. o $ClC_6H_4COOH$ per liter | |
|---|---|
| $H_2O$ layer | $C_6H_5CH_3$ layer |
| 0.00422 | 0.00931 |
| 0.00462 | 0.0110 |
| 0.00528 | 0.0143 |
| 0.00581 | 0.0172 |
| 0.00686 | 0.0238 |
| 0.00792 | 0.0319 |

DISTRIBUTION OF META CHLORO BENZOIC ACID AT 25° BETWEEN:
(Smith and White, 1929.)

Water and Chloroform

| Gm. mol. m $ClC_6H_4COOH$ per liter | |
|---|---|
| $H_2O$ layer | $CHCl_3$ layer |
| 0.00028 | 0.0094 |
| 0.00035 | 0.0114 |
| 0.00042 | 0.0131 |
| 0.00056 | 0.0151 |
| 0.00070 | 0.0175 |

Water and Toluene

| Gm. mol. m $ClC_6H_4COOH$ per liter | |
|---|---|
| $H_2O$ layer | $C_6H_5CH_3$ layer |
| 0.000924 | 0.01148 |
| 0.00099 | 0.0128 |
| 0.00119 | 0.0169 |
| 0.00139 | 0.0222 |
| 0.00152 | 0.0251 |

DISTRIBUTION OF PARA CHLORO BENZOIC ACID AT 25° BETWEEN:
(Smith and White, 1929.)

Water and Chloroform

| Gm. mol. p $ClC_6H_4COOH$ per liter | |
|---|---|
| $H_2O$ layer | $CHCl_3$ layer |
| 0.00021 | 0.0046 |
| 0.00025 | 0.0053 |
| 0.000364 | 0.0067 |
| 0.00049 | 0.0078 |
| 0.00066 | 0.0081 |

Water and Toluene

| Gm. mol. p $ClC_6H_4COOH$ per liter | |
|---|---|
| $H_2O$ layer | $C_6H_5CH_3$ layer |
| 0.000416 | 0.00333 |
| 0.000455 | 0.00351 |
| 0.000520 | 0.00364 |
| 0.000585 | 0.00377 |
| 0.000660 | 0.00440 |

## Distribution of Ortho Chloro Benzoic Acid at 25° Between :

(Smith, 1921-1922.)

| Water and Chloroform. Millimols. o Cl.$C_6H_4$COOH per liter of | | | Water and Ethyl Ether. Millimols. o Cl.$C_6H_4$COOH per liter of | | | Water and Xylene. Millimols. o Cl.$C_6H_4$COOH per liter of | | |
|---|---|---|---|---|---|---|---|---|
| $H_2O$ layer ($C_1$). | $CHCl_3$ layer ($C_2$). | $\frac{C_2}{C_1}$. | $H_2O$ layer ($C_1$). | $(C_2H_5)_2O$ layer ($C_2$). | $\frac{C_2}{C_1}$. | $H_2O$ layer ($C_1$). | $C_6H_4(CH_3)_2$ layer ($C_2$). | $\frac{C_2}{C_1}$. |
| 0.492 | 0.649 | 1.320 | 0.100 | 1.300 | 13.001 | 1.19 | 0.600 | 0.505 |
| 0.649 | 1.072 | 1.655 | 0.145 | 2.415 | 16.65 | 1.55 | 0.975 | 0 630 |
| 0.760 | 1.488 | 1.955 | 0.1925 | 3.7075 | 19.30 | 1.75 | 1.325 | 0.757 |
| 1.075 | 2.690 | 2.50 | 0.250 | 5.67 | 22.65 | 2.30 | 2.20 | 0.956 |
| | | | 1.360 | 9.68 | 26.80 | 4.55 | 7.45 | 1.63 |

## Solubility of Ortho, Meta and Para Chloro Benzoic Acids in Benzene and in Normal Heptane.

(Sidgwick and Ewbank, 1921 *a*.)

| Solvent. | Results for *o* $COOH.C_6H_4.Cl$. t°. | Gms. *o* $COOH.C_6H_4.Cl$ per 100 gms. sat. sol. | Results for *m* $COOH.C_6H_4.Cl$. t°. | Gms. *m* $COOH.C_6H_4.Cl$ per 100 gms. sat. sol. | Results for *p* $COOH.C_6H_4.Cl$ t°. | Gms. *p* $COOH.C_6H_4.Cl$ per 100 gms. sat. sol. |
|---|---|---|---|---|---|---|
| Benzene ... | 140.3 | 100.0 | 154.5 | 100.0 | 241.5 | 100.0 |
| » ... | 129.5 | 90.9 | 142.5 | 94.2 | 232.5 | 92.2 |
| » ... | 113.9 | 70.4 | 125.3 | 71.15 | 212.7 | 72.9 |
| » ... | 99.6 | 50.08 | 108.0 | 49.0 | 194.0 | 52.5 |
| » ... | 82.7 | 29.81 | 93.7 | 30.1 | 172.5 | 30.5 |
| » ... | 57.7 | 9.91 | 65.5 | 9.67 | 137.4 | 10.3 |
| » ... | 44.8 | 5.15 | 51.2 | 4.96 | 119.4 | 5.3 |
| » ... | 26.0 | 1.98 | 35.8 | 2.25 | 93.6 | 1.98 |
| *n* Heptane.. | 134.7 | 88.68 | 147.7 | 89.82 | 227.6 | 76.86 |
| » .. | 129.8 | 68.76 | 140.1 | 70.05 | 218.3 | 51.30 |
| » .. | 126.0 | 36.89 | 134.2 | 50.06 | 207.2 | 31.23 |
| » .. | 112.8 | 12.55 | 128.1 | 30.60 | 180.0 | 10.09 |
| » .. | 108.8 | 10.42 | 105.8 | 9.98 | 165.3 | 4.96 |
| » .. | 94.8 | 4.61 | 89.6 | 4.48 | 136.1 | 1.69 |
| » .. | 79.0 | 2.57 | 72.2 | 1.92 | | |

## Mutual Solubilities of the Three Chlorobenzoic Acids.

(Johnston and Jones, 1928.)

Results for mixtures of:

| o and m $ClC_6H_4COOH$ t° | Mol. % o | Solid Phase | o and p $ClC_6H_4COOH$ t° | Mol. % o | Solid Phase | m and p $ClC_6H_4COOH$ t° | Mol. % m | Solid Phase |
|---|---|---|---|---|---|---|---|---|
| 139.9 | 100 | o | 137.0 | 93.3 | o | 153.5 | 100 | m |
| 135.1 | 90.4 | " | 134.3 | 88.9 | " | 149.0 | 90.9 | " |
| 128.5 | 80.1 | " | 131.8 | — | " + p | 145.3 | 85.3 | " |
| 122.2 | 70.7 | " | 134.9 | 84.8 | p | 140.0 | — | " + p |
| 112.6 | 58.3 | " | 153.0 | 77.5 | " | 145.4 | 77.3 | p |
| 108.7 | — | " + m | 160.3 | 74.3 | " | 176.0 | 62.9 | " |
| 111.3 | 52.1 | m | 170.1 | 70.1 | " | 196.2 | 49.2 | " |
| 123.8 | 40.8 | " | 186.9 | 59.3 | " | 200.2 | 45.9 | " |
| 132.6 | 30.9 | " | 209.4 | 39.4 | " | 212.7 | 35.0 | " |
| 138.7 | 23.5 | " | 220.9 | 26.9 | " | 222.7 | 23.8 | " |
| 144.3 | 15.7 | " | 223.6 | 22.6 | " | 233.3 | 9.6 | " |
| 148.2 | 9.8 | " | 233.5 | 9.6 | " | 239.5 | 0.0 | " |
| 153.5 | 0.0 | " | 239.5 | 0.0 | " | | | |

Several determinations are also given for the ternary system.

## Solubility of Chloro Benzoic Acids in Several Solvents.

(Chapas, 1930.)

Results for Ortho Chloro benzoic acid

| Solvent | t° | Gm. Mol. $ClC_6H_4COOH$ per 100 gm. mols. sat. sol. |
|---|---|---|
| Chloro benzene | 14 | 0.92 |
| " " | 32.2 | 2.09 |
| o chloro toluene | 18.4 | 1.04 |
| " " " | 32.0 | 1.96 |
| p chloro toluene | 19.4 | 1.11 |
| " " " | 32.2 | 1.97 |

Results for Meta Chloro benzoic acid

| Solvent | t° | Gm. Mol. $ClC_6H_4COOH$ per 100 gm. mols. sat. sol. |
|---|---|---|
| Chloro benzene | 32.2 | 1.38 |
| o chloro toluene | 32.5 | 1.56 |
| m " " | 19.4 | 0.83 |
| " " " | 32.5 | 1.55 |

## Fluoro BENZOIC ACIDS o, m and p F. $C_6H_4.COOH$.

### Solubility of Fluoro Benzoic Acids in Water.

| Acid | Gms. F. $C_6H_4COOH$ per liter sat. sol: $25^0$(1) | $32^0$(2) |
|---|---|---|
| Ortho Fluoro Benzoic Acid | 7.23 | 8.82 |
| Meta " " " | 1.50 | 3.08 |
| Para " " " | 1.22 | 1.07 |

(1) Reyer, 1923; (2) Slothouwer, 1914.

### Solubility of Chlorobenzoic Acids in Several Solvents at 14–16°.

(Bornwater and Holleman, 1912.)

| Solvent. | Gms. per 100 cc. Sat. Solution. o $C_6H_4ClCOOH$. | m $C_6H_4ClCOOH$. | p $C_6H_4ClCOOH$. |
|---|---|---|---|
| Ligroin | 0.07 | 0.084 | trace |
| Carbon Tetrachloride | 0.58 | 0.48 | 0.04 |
| Benzene | 0.92 | 0.66 | 0.017 |
| Carbon Disulfide | 0.52 | 0.62 | 0.016 |
| 75% Aq. Acetic Acid | 6.22 | ... | 0.32 |
| Ethyl Ether | 16.96 | 14 | 1.72 |
| Acetone | 28.42 | ... | 2.58 |
| Ethyl Acetate | 13.20 | ... | 1.64 |

## IodoBENZOIC ACID p $C_6H_4ICOOH$.

### Mutual Solubility of Para Iodobenzoic Acid and Water at High Temperatures Determined by the Synthetic Method.

(Flaschner and Rankin, 1910.)

| t° of Melting. | Gms. Acid per 100 Gms. Mixture. | t° of Melting. | Gms. Acid per 100 Gms. Mixture. | t° of Melting. | Gms. Acid per 100 Gms. Mixture. |
|---|---|---|---|---|---|
| 175 crit. sol. t. | | 207 | 22 | 230 | 87.4 |
| 178 | 3 | 210 | 41 | 240 | 92.7 |
| 190 | 5.8 | 215 | 63.5 | 269 | 98.1 |
| 200 | 10 | 220 | 77 | 270 | 100 |

DISTRIBUTION OF ORTHO IODO BENZOIC ACID AT 25° BETWEEN : (Smith, 1921-1922.)

Water and Chloroform.

| Millimols. *o* $I.C_6H_4.COOH$ per liter of $H_2O$ layer ($C_1$). | Millimols. *o* $I.C_6H_4.COOH$ per liter of $CHCl_3$ layer ($C_2$). | $\frac{C_2}{C_1}$. |
|---|---|---|
| 0.248 | 0.512 | 2.06 |
| 0.244 | 0.493 | 2.02 |
| 0.287 | 0.680 | 2.37 |
| 0.335 | 0.973 | 2.90 |
| 0.473 | 1.990 | 4.21 |

Water and Ethyl Ether.

| Millimols. (*o*) $I.C_6H_4.COOH$ per liter of $H_2O$ layer ($C_1$). | Millimols. (*o*) $I.C_6H_4.COOH$ per liter of $(C_2H_5)_2O$ layer ($C_2$). | $\frac{C_2}{C_1}$. |
|---|---|---|
| 0.0238 | 0.505 | 21.2 |
| 0.0400 | 0.861 | 21.5 |
| 0.0602 | 1.400 | 23.2 |
| 0.1010 | 2.640 | 26.2 |

Water and Xylene.

| Millimols. (*o*) $I.C_6H_4.COOH$ per liter of $H_2O$ layer ($C_1$). | Millimols. (*o*) $I.C_6H_4.COOH$ per liter of $C_6H_4(CH_3)_2$ layer ($C_2$). | $\frac{C_2}{C_1}$. |
|---|---|---|
| 0.325 | 0.175 | 0.538 |
| 0.60 | 0.55 | 0.916 |
| 1.10 | 2.20 | 2.00 |

Freezing-point-data are given for mixtures of:

o, m and p Chloro benzoic acids(1)
o, m and p Iodo benzoic acids(3)
Bromo benzoic acid + Iodo benzoic acid(3)
Chloro " " + " " " (3)
" " " + Benzoic acid(1)(2)
" " " + 2.5 di chloro benzoic acid(2)
Iodo " " + Benzoic acid(3)
" " " + Methyl benzoic acid(3)
" " " + Oxy benzoic acid(3)
Fluoro " " + Benzoic acid(4)

(1) Bornwater and Holleman, 1912; (2) Hope and Riley, 1923; (3) Lettre and Lehmann, 1938; (4) Koopal, 1911.

Nitro **BENZAL CHLORIDE** (Nitro benzylidene chloride) $NO_2C_6H_4CHCl_2$.

Freezing-point data for mixtures of o, m and p nitro benzylidene chlorides are given by Holleman, 1914; Holleman, Vermeulen and de Mooy, 1914; and Vermeulen, 1914, 1928.

**SACCHARIN** (1, Benzosulfonazole, 2(1), one) $C_6H_4<\begin{matrix}SO_2\\CO\end{matrix}>NH$.

100 parts $H_2O$ dissolve 0.4 part at 25° and 4.17 parts at 100°. (U. S. P. VIII.)
100 parts alcohol dissolve 4 parts at 25°.
100 gms. trichlorethylene dissolve 0.012 gm. saccharin at 15°. (Wester and Bruins, 1914.)

DISTRIBUTION OF SACCHARIN AT 25° BETWEEN:

Water * and Ether.
(Marden, 1914.)

| Gms. Saccharin per: 100 cc. $H_2O$ Layer. | Gms. Saccharin per: 50 cc. Ether Layer. | Dist. Coef. |
|---|---|---|
| 0.0290 | 0.0438 | 0.267 |
| 0.0458 | 0.0829 | 0.235 |
| 0.0719 | 0.1245 | 0.245 |

* Slightly acidified with HCl.

Water † and Amyl Acetate.
(Marden, 1914.)

| Gms. Saccharin per: 105 cc. Aq. Layer. | Gms. Saccharin per: 50 cc. Amyl Acetate Layer. | Dist. Coef. |
|---|---|---|
| 0.0045 | 0.0700 | 0.0306 |
| 0.0065 | 0.0957 | 0.0322 |
| 0.0114 | 0.1724 | 0.0315 |

† Containing 5 cc. conc. HCl per 100 cc.

The amount of saccharin entering the ethereal layer is increased by addition of HCl to the aqueous layer. With 5 cc. conc. HCl per 100 cc. $H_2O$, the distribution coefficient is reduced to 0.0624.

SOLUBILITY OF SACCHARIN IN MIXTURES OF ALCOHOL AND QUINOLINE AT 20-25°.
(Pucher and Dehn, 1921.)

| Per cent quinoline in solvent..... | 0.0 (=$C_2H_5OH$) | 10.0 | 23.2 | 55.0 | 70.0 | 80.0 | 90.0 | 100.0 |
|---|---|---|---|---|---|---|---|---|
| Gms. saccharin per 100 gms. solvent. | 2.0 | 2.5 | 3.3 | 6.0 | 7.01 | 8.05 | 8.8 | 10.1 |

## Nitro**BENZALDEHYDES** *o*, *m* and *p* $C_6H_4NO_2.CHO$.

### Solubility of Ortho, Meta and Para Nitrobenzaldehydes in Water.

(Sidgwick and Dash, 1922.)

The sealed tube method was used at the higher temperatures and the Beckmann apparatus at the lower. The temperatures of the triple points (tr. pt.) corresponding to solid aldehyde in contact with two liquid layers, were determined in separate experiments and the composition estimated by extrapolation on the plotted curves. S indicates solid nitrobenzaldehyde. The complete solubility curves were realized for the meta and para compounds but that for the ortho compound could not be taken above 100° on account of decomposition.

Results for Ortho Nitro benzaldehyde.

| t°. | Wt. % *o* $C_6H_4NO_2.CHO$. |
|---|---|
| 66.9..... | 0.70 |
| 103.1..... | 1.53 |
| 166.0..... | 4.75 |
| – ..... | – |
| 161.7..... | 93.56 |
| 145.1..... | 94.80 |
| 113.5..... | 96.49 |
| 63.8..... | 99.00 |
| 43.5..... | 100.00 |
| 39.7(tr. pt.).. | 99.9 |

Results for Meta Nitro benzaldehyde.

| t°. | Wt. % *m* $C_6H_4NO_2.CHO$. | t°. | Wt. % *m* $C_6H_4NO_2.CHO$. |
|---|---|---|---|
| 40.5..... | 0.39 S | 212..... | (crit. sol. temp.) |
| 75.1..... | 0.96 | 211.7..... | 56.23 |
| 111.9 ..... | 1.95 | 195.3..... | 78.77 |
| 136.4..... | 3.01 | 179.3..... | 86.75 |
| 147.1..... | 3.95 | 167.0..... | 90.18 |
| 157.3..... | 4.92 | 152.0..... | 92.87 |
| 181.0..... | 10.51 | 126.2..... | 95.67 |
| 191.4..... | 14.03 | 85.2. .... | 97.83 |
| 205.4..... | 23.35 | 58.0..... | 100.00 |
| 211.8..... | 39.62 | 51.0 (tr. pt.). | 99.6 |

Results for Para Nitro benzaldehyde.

| t°. | Wt. % *p* $C_6H_4NO_2.CHO$. | t°. | Wt. % *p* $C_6H_4NO_2.CHO$. | t°. | Wt. % *p* $C_6H_4NO_2.CHO$. |
|---|---|---|---|---|---|
| 90.2..... | 0.97 S | 216.... | (crit. sol. temp.) | 164.6..... | 92.74 |
| 132.4..... | 2.91 | 215.7.. | 51.92 | 134.2..... | 96.70 |
| 176.5..... | 8.78 | 213.4.. | 63.19 | 106.5..... | 100.00 |
| 205.4..... | 20.67 | 172.6.. | 90.65 | 97.1 (tr. pt.). | 98.2 |
| 215.5..... | 37.77 | | | | |

100 gms. abs. Alcohol dissolve 22.14 gms. Nitro benzaldehyde at 20-25°. (Pucher and Dehn, 1921.)
» » Quinoline » 1.96 » » » » »
100 gms. equi-mol. mixture of Alcohol and Quinoline dissolve 7.07 gms. Nitro benzaldehyde at 20-25°.

## Meta Nitro**BENZALDEHYDE** *m* $C_6H_4NO_2.CHO$.

100 cc. $H_2O$ dissolve 0.1625 gm. *m* $C_6H_4NO_2.CHO$ at 25° (Goldschmidt and Sunde, 1906.)
" 1 *n* HCl " 0.1813 " " " " " "
" 1 *n* KCl " 0.1542 " " " " " "
" 2 *n* KCl " 0.1417 " " " " " "

## Ortho Nitro**BENZALDEHYDE** *o* $C_6H_4NO_2.CHO$.

### Solubility in Water and in Aqueous Solutions at 25°.

(Goldschmidt and Sunde, 1906.)

| Solvent. | Gms. $C_6H_4NO_2$. CHO per 100 cc. Sat. Sol. | Solvent. | Gms. $C_6H_4NO_2$. CHO per 100 cc. Sat. Sol. | Solvent. | Gms. $C_6H_4NO_2$ CHO per 100 cc. Sat. Sol. |
|---|---|---|---|---|---|
| $H_2O$ | 0.2316 | 1 *n* NaCl | 0.1899 | 1 *n* $KNO_3$ | 0.3199 |
| 0.5 *n* HCl | 0.2391 | 2 *n* " | 0.1390 | 2 *n* " | 0.3419 |
| 1 *n* " | 0.2466 | 0.5 *n* $HNO_3$ | 0.3207 | 0.5 *n* $NaNO_3$ | 0.3013 |
| 2 *n* " | 0.2658 | 1 *n* " | 0.3758 | 1 *n* " | 0.3132 |
| 1 *n* KCl | 0.2046 | 0.5 *n* $KNO_3$ | 0.3123 | 2 *n* " | 0.3201 |
| 2 *n* " | 0.1912 | | | | |

SOLUBILITY OF ORTHO, META AND PARA NITROBENZALDEHYDES IN BENZENE
(Sidgwick and Dash, 1922.)

See remarks, preceding page. B = solid benzene.

| Ortho Nitrobenzaldehyde Wt. % | | Meta Nitrobenzaldehyde Wt. % | | Para Nitrobenzaldehyde Wt. % | |
|---|---|---|---|---|---|
| t°. | *o* $C_6H_4NO_2.CHO$. | t°. | *m* $C_6H_4NO_2.CHO$ | t°. | *p* $C_6H_4NO_2.CHO$. |
| 5.1..... | 1.17 B | 5.0..... | 1.20 B | 5.3..... | 0.00 B |
| 4.7..... | 2.47 B | 4.7..... | 2.40 B | 5.0..... | 1.00 B |
| 4.4..... | 3.51 B | 4.3..... | 4.28 B | 4.6..... | 2.00 B |
| 3.9..... | 4.98 B | 4.0..... | 4.98 B | 4.4..... | 2.75 B |
| 2.7..... | 10.12 B | 2.4..... | 10.14 B | 4.1..... | 3.57 B |
| 1.2..... | 15.18 B | 1.0..... | 15.15 B | 4.1 (Eutec.) | 3.6 |
| — 0.4..... | 20.09 B | — 0.8 (Eutec.) | 15.75 | 7.5..... | 4.06 |
| — 1.5..... | 25.23 B | + 0.9..... | 16.16 | 12.6..... | 5.01 |
| — 1.7 (Eutec.) | 26.50 | 2.8..... | 17.55 | 23.4..... | 7.57 |
| — 1.2..... | 26.85 | 4.9..... | 19.03 | 30.8..... | 10.15 |
| + 1.2..... | 29.59 | 9.8..... | 23.55 | 40.5..... | 15.00 |
| 4.9..... | 35.35 | 14.7..... | 28.43 | 48.3..... | 20.53 |
| 8.2..... | 40.24 | 18.5..... | 33.77 | 57.5..... | 29.61 |
| 11.3..... | 45.48 | 21.7..... | 38.91 | 62.2..... | 35.31 |
| 13.0..... | 48.84 | 25.6..... | 47.68 | 65.7..... | 40.42 |
| 15.8..... | 54.40 | 29.4..... | 54.53 | 71.3..... | 49.82 |
| 19.4..... | 60.74 | 33.0..... | 62.30 | 77.2..... | 61.12 |
| 24.6..... | 70.98 | 36.3..... | 68.87 | 81.0..... | 67.56 |
| 27.2..... | 76.28 | 39.2..... | 74.35 | 84.9..... | 73.54 |
| 30.2..... | 81.60 | 41.2..... | 78.36 | 87.8..... | 78.85 |
| 34.1..... | 87.82 | 43.9..... | 83.23 | 93.0..... | 85.54 |
| 39.1..... | 95.08 | 47.7..... | 88.80 | 98.6..... | 92.83 |
| 43.5..... | 100.00 | 51.7..... | 94.49 | | |
| | | 58.0..... | 100.00 | | |

Freezing-point data are given for mixtures of o, m and p Nitrobenzaldehydes by Brady and Harris, 1923. Results are given for mixtures of Nitrobenzaldehydes and:

Acetic anhydride(1)(10)
Acenaphthene(4)
Benzene(7)
Hexane(8)
Naphthol(2)(3)
Nitro mannitol(9)
Nitrobenzene(8)
Phenol(7)
Sulfuric acid(5)
Tri chloracetic acid(6)

(1) Baume and others, 1914; (2) Dischendorfer, 1928; (3) Dischendorfer and Nesitka, 1928; (4) de Fazi, 1916; (5) Kendall, 1914; (6) Kendall and Gibbons, 1915; (7) Schmidlin and Lang, 1912; (8) Timmermans, 1907; (9) Urbanski, 1934; (10) Van der Beek, 1928.

## Nitro BENZOIC ACIDS (o), (m) and (p) $NO_2.C_6H_4COOH$.

SOLUBILITY OF NITRO BENZOIC ACIDS IN WATER AT 25°.

| Acid | Gms. $NO_2.C_6H_4COOH$ per liter sat. sol. | | |
|---|---|---|---|
| Ortho Nitro Benzoic Acid | 7.40(1) | 7.85(2) | 4.18(3) |
| Meta " " " | 3.56(4) | 3.57(2) | 3.28(3) |
| Para " " " | — | | 0.57(3) |

(1) Larsson, 1927; (2) Knox and Richards, 1919; (3) Reyer, 1923; (4) Collett and Lazzell, 1930.

## Nitro BENZOIC ACIDS (*o*), (*m*) and (*p*) $NO_2.C_6H_4COOH$.

### Solubility of Ortho, Meta and Para Nitro Benzoic Acids in Water.

(Sidgwick and Ewbank, 1921*a*: Results below 43°. Tajnik, Jain and Nath, 1925.)

| Results for Ortho Nitro Benzoic Acid. | | Results for Meta Nitro Benzoic Acid. | | Results for Para Nitro Benzoic Acid. | |
|---|---|---|---|---|---|
| t°. | Gms. *o* $NO_2.C_6H_4COOH$ per 100 gms. sat. sol. | t°. | Gms. *m* $NO_2.C_6H_4COOH$ per 100 gms. sat. sol. | t°. | Gms. *p* $NO_2.C_6H_4COOH$ per 100 gms. sat. sol. |
| 146.8... | 100.0 | 141.4... | 100.0 | 242.4... | 100.0 |
| 110.4... | 90.38 | 104.8... | 89.76 | 184.8... | 79.22 |
| 90.5... | 79.32 | 85.4... | 79.52 | 168.6... | 59.21 |
| 79.5... | 59.85 | 97.7... | 60.85 (L) | 163.5... | 38.30 |
| 78.0... | 39.92 | 108.4... | 40.31 (L) | 158.8... | 18.50 |
| 77.5... | 19.24 | 107.8... | 19.85 (L) | 153.0... | 9.47 |
| 75.3... | 9.48 | 99.3... | 9.90 (L) | 177.0... | 0.88 |
| 49.5... | 1.85 | 79.3... | 1.57 (L) | 42.0... | 0.022 |
| 42.0... | 2.28 | 42.0... | 0.515 | 35.0... | 0.025 |
| 35..... | 1.30 | 35.0... | 0.418 | 25.0... | 0.028 |
| 25..... | 0.75 | 25.0... | 0.344 | | |

(L) a second liquid phase separates. Crit. temp. for *m* nitrobenzoic acid, 109°.0 and tr. pt. 76°.8.

### Solubility of Ortho Nitrobenzoic Acid in Water. (Noyes and Sammet, 1903.)

| t°. | $C_6H_4NO_2COOH$ *o* per Liter Sol. | | t°. | $C_6H_4NO_2COOH$ *o* per Liter Sol. | |
|---|---|---|---|---|---|
| | Millimols. | Grams. | | Millimols. | Grams. |
| 10 | 26.62 | 4.645 | 25 | 43.3 | 7.231 |
| 15 | 31.06 | 5.187 | 30 | 51.6 | 8.616 |
| 20 | 36.57 | 6.106 | | | |

Additional determinations by other investigators, in millimols $C_6H_4NO_2COOH$ *o* per liter at 25°, are: 46.5 (van Maarseveen, 1898); 44.19 (Paul, 1894); 42.3 (Holleman, 1898); 43.6 (Kendall, 1911).

### Solubility of Ortho, Meta and Para Nitrobenzoic Acids in Water, at High Temperatures, Determined by the Synthetic Method.

(Flaschner and Rankin 1910.)

| *o* $C_6H_4NO_2COOH+H_2O$. | | *m* $C_6H_4NO_2COOH+H_2O$. | | | *p* $C_6H_4NO_2COOH+H_2O$. | | |
|---|---|---|---|---|---|---|---|
| t° of Melting. | Gms. Acid per 100 Gms. Sat. Sol. | t° of: Melting. | t° of: Solution. | Gms. Acid per 100 Gms. Sat. Sol. | t° of Melting. | Gms. Acid per 100 Gms. Sat. Sol. |
| 52 crit. t. | ... | 63.2 | ... | 2 | 118 crit. t. | ... |
| 69 | 5 | 77.4 | ... | 6 | 143 | 5 |
| 75 | 9.9 | 77.4 | 90 | 7 | 150 | 9 |
| 78 | 13.5 | 77.4 | 100 | 10.5 | 155 | 14.5 |
| 79 | 49.5 | 77.4 | 105 | 17 | 160 | 30 |
| 80 | 62 | 77.4 | 107.5 crit. t. | 30 | 165 | 53.5 |
| 85 | 73.5 | 77.4 | 106 | 50 | 170 | 65.5 |
| 90 | 78.6 | 77.4 | 100 | 58.6 | 180 | 76.7 |
| 100 | 83.5 | 77.4 | 90 | 65.4 | 190 | 83.2 |
| 120 | 94 | 80 | ... | 74 | 200 | 88 |
| 148 | 100 | 100 | ... | 88.5 | 220 | 95.2 |
| | | 120 | ... | 96.8 | 237 | 100 |
| | | 140.4 | ... | 100 | | |

Data for the solubility of mixtures of *o*, *m* and *p* nitrobenzoic acids in water at 24.4° are given by Holleman (1898).

### Solubility of Ortho Nitrobenzoic Acid in Aqueous Solutions of Hydrochloric, Formic, Malonic and Salicylic Acids at 25°. (Kendall, 1911.)

| Solvent. | Normality of Solvent. | Gms. *o* $C_6H_4NO_2COOH$ per Liter Sat. Solution. | Solvent. | Normality of Solvent. | Gms. *o* $C_6H_4NO_2.COOH$ per Liter Sat. Solution. |
|---|---|---|---|---|---|
| HCl | 0.0179 | 6.146 | $CH_2(COOH)_2$ | 0 | 7.281 |
| " | 0.0357 | 5.661 | " | 0.0313 | 7.144 |
| " | 0.125 | 4.976 | " | 0.1001 | 6.934 |
| " | 0.250 | 4.997 | " | 0.2004 | 6.656 |
| " | 0.500 | 4.752 | $C_6H_4(OH)COOH$ | 0.0094 | 7.276 |
| HCOOH | 0.0517 | 7.188 | " | 0.0136 | 7.352 |
| " | 0.0998 | 7.124 | " | 0.0162 | 7.369 |

## Solubility of Ortho and of Meta Nitro Benzoic Acid, Each Separately, in Aqueous Solutions of Hydrochlorid Acid at 25°.

(Knox and Richards, 1919.)

Results for Ortho Nitro Benzoic Acid

| Equiv. HCl | Normality per liter of: o $NO_2 \cdot C_6H_4 \cdot COOH$ |
|---|---|
| 0.00 | 0.0470 |
| 1.314 | 0.0280 |
| 2.607 | 0.0256 |
| 3.909 | 0.0239 |
| 5.013 | 0.0235 |
| 6.509 | 0.0233 |
| 7.795 | 0.0237 |
| 9.080 | 0.0250 |
| 10.30 | 0.0267 |

Results for Meta Nitro Benzoic Acid

| Equiv. HCl | Normality per liter of: o $NO_2 \cdot C_6H_4 \cdot COOH$ |
|---|---|
| 0.00 | 0.0214 |
| 1.416 | 0.0175 |
| 3.310 | 0.0178 |
| 4.308 | 0.0183 |
| 5.953 | 0.0205 |
| 7.044 | 0.0225 |
| 8.380 | 0.0256 |
| 9.793 | 0.0293 |
| 11.54 | 0.0368 |

## Solubility of Ortho Nitro Benzoic Acid in Aqueous Solutions of Acids at 25°.

(Drucker, 1929.)

Results for aqueous solutions of:

| Hydrochloric Acid | | Nitric Acid | | Sulfuric Acid | | Picric Acid | |
|---|---|---|---|---|---|---|---|
| Gm. Equiv. per liter | | Gm. Equiv. per liter | | Gm. Equiv. per liter | | Gm. Equiv. per liter | |
| HCl | o $NO_2C_6H_4COOH$ | $HNO_3$ | o $NO_2C_6H_4COOH$ | $H_2SO_4$ | o $NO_2C_6H_4COOH$ | $OHC_6H_2(NO_2)_3$ | o $NO_2C_6H_4COOH$ |
| 0.00545 | 0.04073 | 0.00636 | 0.04127 | 0.00598 | 0.04247 | 0.000 | 0.04325 |
| 0.01089 | 0.03970 | 0.01436 | 0.03891 | 0.01074 | 0.04100 | 0.00417 | 0.04096 |
| 0.02203 | 0.03555 | 0.02565 | 0.03587 | 0.02277 | 0.03772 | 0.00905 | 0.03987 |
| 0.04416 | 0.03287 | 0.05174 | 0.03308 | 0.03896 | 0.03528 | 0.01601 | 0.03900 |
| 0.11098 | 0.02861 | 0.0876 | 0.03372 | 0.1088 | 0.02885 | 0.04336 | 0.04028 |

## Solubility of Ortho Nitrobenzoic Acid and of Para Nitrobenzoic Acid, Each Separately, in Aqueous Solutions of Sulfuric Acid at 25°.

(Hammett and Chapman, 1934.)

Results for Ortho Nitrobenzoic Acid

| Wt. % $H_2SO_4$ in aq. solvent | Gm. Mols. o $NO_2C_6H_4COOH$ per 1000 gms. aq. solvent | Wt. % $H_2SO_4$ in aq. solvent | Gm. Mols. o $NO_2C_6H_4COOH$ per 1000 gms. aq. solvent |
|---|---|---|---|
| 0.0 | 0.0435 | 60.83 | 0.0088 |
| 11.28 | 0.0192 | 65.07 | 0.0095 |
| 19.79 | 0.0139 | 72.46 | 0.0141 |
| 31.23 | 0.0095 | 79.28 | 0.0310 |
| 41.90 | 0.0080 | 81.75 | 0.0469 |
| 46.74 | 0.0076 | 83.61 | 0.0737 |
| 52.01 | 0.0080 | 85.13 | 0.1017 |

Results for Para Nitrobenzoic Acid

| Wt. %. $H_2SO_4$ in aq. solvent | Gm. Mols. p $NO_2C_6H_4COOH$ per 1000 gms. aq. solvent | Wt. % $H_2SO_4$ in aq. solvent | Gm. Mols. p $NO_2C_6H_4COOH$ per 1000 gms. aq. solvent |
|---|---|---|---|
| 0.0 | 0.00166 | 80.41 | 0.00540 |
| 31.23 | 0.00068 | 81.75 | 0.00708 |
| 52.01 | 0.00079 | 83.61 | 0.01197 |
| 72.46 | 0.00179 | 85.13 | 0.01908 |
| 77.40 | 0.00316 | 90.05 | 0.0983 |
| 79.28 | 0.00452 | | |

### Solubility of Ortho, Meta and Para Nitro Benzoic Acids in Aqueous Solutions of Electrolytes at 35°. (Yajnik, Jain and Nath, 1925.)

Saturated solutions of the acids were prepared at 45° and 100 cc. portions placed in flasks containing accurately weighed quantities of the various electrolytes. These were kept in a thermostat at 35° but no mention is made of stirring or agitation during the period of attainment of equilibrium. The acid present was determined by titration with standard alkali. Nothing is said about the separation of the solid phase. This is especially regretable in the case of *p* nitro benzoic acid, which according to the authors' figures, is less soluble with increase of temperature. Also in some cases the reported increase in solubility with increase of concentration of electrolyte, is greater than the amount of acid which could have been present in a mixture made as described

| | Results for Ortho Nitro Benzoic Acid. | | Results for Meta Nitro Benzoic Acid. | | Results for Para Nitro Benzoïc Acid. | |
|---|---|---|---|---|---|---|
| Electrolyte used. | Gm. mol. electrolyte per 100 gms. $H_2O$. | Gm. $o\,NO_2.C_6H_4COOH$ per 100 gms. $H_2O$. | Gm. mol. electrolyte per 100 gms. $H_2O$. | Gm. $m\,NO_2.C_6H_4COOH$ per 100 gms. $H_2O$. | Gm. mol. electrolyte per 100 gms. $H_2O$ | Gm. $p\,NO_2.C_6H_4COOH$ per 100 gms. $H_2O$. |
| $(NH_4)_2SO_4$. | 0.0000 | 1.30 | 0.000 | 0.418 | 0.000 | 0.025 |
| » . | 0.0016 | 1.245 | 0.0017 | 0.3105 | 0.0031 | 0.027 |
| » . | 0.0030 | 1.222 | 0.0030 | 0.2593 | 0.0042 | 0.028 |
| » . | 0.0050 | 1.191 | 0.0048 | 0.2616 | 0.0087 | 0.029 |
| » . | 0.0067 | 1.163 | 0.0064 | 0.2554 | 0.0102 | 0.0295 |
| » . | 0.0082 | 1.136 | 0.0097 | 0.2446 | 0.0125 | 0.029 |
| $Na_2SO_4$... | 0.0014 | 1.295 | 0.0020 | 0.3235 | 0.0018 | 0.0269 |
| » ... | 0.0033 | 1.232 | 0.0032 | 0.2848 | 0.0040 | 0.0289 |
| » ... | 0.0053 | 1.154 | 0.0051 | 0.2771 | 0.0051 | 0.0306 |
| » ... | 0.0071 | 1.039 | 0.0073 | 0.2687 | 0.0076 | 0.0309 |
| » ... | 0.0078 | 0.072 (?) | 0.0089 | 0.2616 | 0.0102 | 0.0315 |
| $K_2SO_4$.... | 0.0015 | 1.310 | 0.0016 | 0.3317 | 0.0017 | 0.0272 |
| » .... | 0.0020 | 1 254 | 0.0027 | 0.2987 | 0.0027 | 0.0281 |
| » .... | 0.0026 | 1.181 | 0.0039 | 0.2906 | 0.0047 | 0.0288 |
| » .... | 0.0045 | 1.098 | 0.0048 | 0.2910 | 0.0063 | 0.0295 |
| » .... | 0.0071 | 0.981 | 0.0063 | 0.2848 | 0.0084 | 0.0300 |
| $NH_4Cl$.... | 0.0046 | 1.256 | 0.0036 | 0.2043 | 0.0052 | 0.0346 |
| » .... | 0.0058 | 1.227 | 0.0060 | 0.1950 | 0.0084 | 0.0353 |
| » .... | 0.0079 | 1.199 | 0.0078 | 0.1895 | 0.0103 | 0.0352 |
| » .... | 0.0094 | 1.193 | 0.0100 | 0.1830 | 0.0137 | 0.0343 |
| » .... | 0.0117 | 1.171 | 0.0148 | 0.1672 | 0.0178 | 0.0320 |
| NaCl ..... | 0.0041 | 1 241 | 0.0070 | 0.2059 | 0.0065 | 0.0358 |
| » ..... | 0.0058 | 1.186 | 0.0088 | 0.1903 | 0.0135 | 0.0355 |
| » ..... | 0.0094 | 1.126 | 0.0125 | 0.1718 | 0.0152 | 0.0353 |
| » ..... | 0.0131 | 1.068 | 0.0171 | 0.1485 | 0.0184 | 0.0347 |
| » ..... | 0.0155 | 1.040 | 0.0237 | 0.1223 | 0.0257 | 0.0324 |
| KCl..... | 0.0031 | 1.228 | 0.0033 | 0.2337 | 0.0035 | 0.0328 |
| » ..... | 0.0053 | 1.213 | 0.0075 | 0.2213 | 0.0049 | 0.0342 |
| » ..... | 0.0069 | 1.181 | 0.0116 | 0.2090 | 0.0079 | 0.0361 |
| » ..... | 0 0088 | 1.149 | 0.0154 | 0.1981 | 0.0096 | 0.0359 |
| » ..... | 0.0112 | 1.024 | 0.0197 | 0.1857 | 0.0143 | 0.0350 |
| $CaCl_2$..... | 0.0015 | 1.334 | 0.0023 | 0.2525 | 0 0027 | 0.0348 |
| » ..... | 0.0028 | 1.364 | 0.0038 | 0.2368 | 0.0034 | 0.0352 |
| » ..... | | | 0.0058 | 0.2291 | 0.0067 | 0.0323 |
| » ..... | | | 0.0085 | 0.2229 | 0.0088 | 0.0283 |
| » ..... | | | 0.0113 | 0.2463 | 0.0099 | 0.0278 |

$C_7H_5O_4$

## Nitro **BENZOIC ACIDS**

Solubility of Ortho, Meta and Para Nitro Benzoic Acids in Aqueous Solutions of Electrolytes at 35°. (*con.*)

| | Results for Ortho Nitro Benzoic Acid. | | Results for Meta Nitro Benzoic Acid. | | Results for Para Nitro Benzoic Acid. | |
|---|---|---|---|---|---|---|
| Electrolyte used. | Gm. mol. electrolyte per 100 gms. $H_2O$. | Gm. $o\,NO_2.C_6H_4COOH$ per 100 gms. $H_2O$. | Gm. mol. electrolyte per 100 gms. $H_2O$. | Gm. $m\,NO_2.C_6H_4COOH$ per 100 gms. $H_2O$. | Gm. mol. electrolyte per 100 gms. $H_2O$. | Gm. $p\,NO_2.C_6H_4COOH$ per 100 gms. $H_2O$. |
| $SrCl_2$..... | 0.0052 | 1.878 | 0.0010 | 0.2650 | 0.0013 | 0.0341 |
| » ..... | 0.0059 | 1.332 | 0.0017 | 0.2430 | 0.0024 | 0.0356 |
| » ..... | 0.0075 | 1.213 | 0.0025 | 0.2384 | 0.0035 | 0.0366 |
| » ..... | | | 0.0039 | 0.2348 | 0.0047 | 0.0339 |
| » ..... | | | 0.0040 | 0.2270 | 0.0055 | 0.0298 |
| $BaCl_2$ .... | 0.0012 | 1.330 (1.388) | 0.0013 | 0.2615 | 0.0013 | 0.0339 |
| » ..... | 0.0021 | 1.365 (1.420) | 0.0018 | 0.2523 | 0.0021 | 0.0363 |
| » .... | 0.0029 | 1.416 (1.485) | 0.0024 | 0.2446 | 0.0037 | 0.0382 |
| » .... | 0.0040 | 1.464 (1.510) | 0.0033 | 0.2399 | 0.0041 | 0.0370 |
| » .... | 0.0051 | 1.419 (1.464) | 0.0041 | 0.2368 | 0.0053 | 0.0311 |
| $NH_4NO_3$.. | 0.0028 | 1.313 | 0.0028 | 0.2189 | 0.0047 | 0.0402 |
| » .. | 0.0046 | 1.332 | 0.0038 | 0.1718 | 0.0085 | 0.0413 |
| » .. | 0.0062 | 1.337 | 0.0049 | 0.1563 | 0.0103 | 0.0414 |
| » .. | 0.0078 | 1.298 | 0.0069 | 0.1315 | 0.0137 | 0.0405 |
| » .. | 0.0093 | 1.252 | 0.0082 | 0.1160 | 0.0165 | 0.0396 |
| $NaNO_3$... | 0.0026 | 1.318 | 0.0016 | 0.2199 | 0.0036 | 0.0405 |
| » ... | 0.0050 | 1.314 | 0.0032 | 0.1842 | 0.0070 | 0.0417 |
| » ... | 0.0077 | 1.297 | 0.0057 | 0.1625 | 0.0094 | 0.0418 |
| » ... | 0.0113 | 1.277 | 0.0078 | 0.1449 | 0.0112 | 0.0413 |
| » ... | 0.0137 | 1.250 | 0.0101 | 0.1254 | 0.0144 | 0.0401 |
| $KNO_3$ .... | 0.0028 | 1.391 | 0.0017 | 0.2548 | 0.0028 | 0.0396 |
| » .... | 0.0052 | 1.355 | 0.0032 | 0.1996 | 0.0052 | 0.0414 |
| » .... | 0.0088 | 1.319 | 0.0052 | 0.1780 | 0.0078 | 0.0423 |
| » .... | 0.0139 | 1.272 | 0.0071 | 0.1563 | 0.0111 | 0.420 |
| » .... | 0.0181 | 1.231 | 0.0083 | 0.1408 | 0.0122 | 0.0415 |
| $Ca(NO_3)_2$. | 0.0017 | 1.715 | 0.0016 | 0.2427 | 0.0013 | 0.0393 |
| » . | 0.0027 | 1.688 | 0.0033 | 0.2290 | 0.0022 | 0.0436 |
| » . | 0.0042 | 1.629 | 0.0043 | 0.2215 | 0.0036 | 0.0441 |
| » . | 0.0050 | 1.616 | 0.0050 | 0.2187 | 0.0050 | 0.0430 |
| » . | 0.0061 | 1.570 | 0.0065 | 0.2161 | 0.0063 | 0.0402 |
| $Sr(NO_3)_2$. | 0.0016 | 1.783 | 0.0012 | 0.2363 | 0.0014 | 0.0418 |
| » . | 0.0025 | 1.752 | 0.0023 | 0.2284 | 0.0023 | 0.0445 |
| » . | 0.0033 | 1.711 | 0.0028 | 0.2244 | 0.0031 | 0.0461 |
| » . | 0.0042 | 1.676 | 0.0050 | 0.2161 | 0.0049 | 0.0416 |
| » . | 0.0055 | 1.610 | 0.0061 | 0.2140 | 0.0068 | 0.0337 |
| $Ba(NO_3)_2$. | 0.0015 | 1.830 | 0.0013 | 0.2343 | 0.0008 | 0.0380 |
| » . | 0.0020 | 1.788 | 0.0018 | 0.2336 | 0.0018 | 0.0427 |
| » . | 0.0024 | 1.754 | 0.0024 | 0.2290 | 0.0023 | 0.0447 |
| » . | 0.0033 | 1.677 | 0.0033 | 0.2235 | 0.0032 | 0.0473 |
| » . | 0.0045 | 1.570 | 0.0041 | 0.2202 | 0.0037 | 0.0461 |

## Solubility of Ortho Nitrobenzoic Acid in Aqueous Solutions of Sodium Butyrate, Acetate, Formate, and Salicylate at 26.4°.

(Philip, 1905.)

Original results in terms of $\frac{\text{Mols.}}{100}$ per liter.

| Gms. Na Salt per Liter. | Gms. Ortho $C_6H_4COOH.NO_2$ per Liter of Solution in: | | | |
|---|---|---|---|---|
| | $C_3H_7COONa$. | $CH_3COONa$. | HCOONa. | $C_6H_4.OH.COONa$. |
| 0 | 7.85 | 7.85 | 7.85 | 7.85 |
| 0.5 | 8.35 | 8.50 | 8.60 | 8.35 |
| 1.0 | 8.90 | 9.15 | 9.50 | 8.70 |
| 2 | 10.0 | 10.80 | 11.5 | 9.4 |
| 3 | 11.2 | 12.55 | 13.5 | 11.0 |
| 4 | 12.4 | 14.5 | 15.6 | 11.5 |
| 6 | 15.2 | ... | ... | ... |

One liter Aq. 0.12 normal solution of Sodium Chlor acetate, sat. with Ortho nitrobenzene, contain 0.1099 gm. mols. (= 18.353 gms.) o $NO_2C_6H_4COOH$ at 25°. (Larsson, 1927.)

## Solubility of Meta Nitrobenzoic Acid in Aqueous Solutions of Magnesium Sulfate at 25°.

(Randall and Failey, 1927.)

| "Ionic Strength" of Aq. $MgSO_4$ Solution | Gm. Mols. (x2?) $\underline{m}$ $NO_2C_6H_4COOH$ per liter sat. sol. | "Ionic Strength" of Aq. $MgSO_4$ Solution | Gm. Mols. (x2?) $\underline{m}$ $NO_2C_6H_4COOH$ per liter sat. sol. |
|---|---|---|---|
| 0.00 | 0.04415 (= 7.37 gms.) | 0.400 | 0.05490 |
| 0.04792 | 0.04783 | 0.640 | 0.05633 |
| 0.100 | 0.05011 | 0.9836 | 0.05679 |
| 0.200 | 0.05241 | | |

## Solubility of Meta Nitrobenzoic Acid in Aqueous Solutions of Sodium Acetate, Sodium Formate, Sodium Monochloracetate and Potassium Formate at 25°.

(Philip and Garner, 1909.)

| In $CH_3COONa$. | | In HCOONa. | | In $CH_2ClCOONa$. | | In HCOOK. | |
|---|---|---|---|---|---|---|---|
| Gms per Liter. | | Gms. per Liter. | | Gms. per Liter. | | Gms. per Liter. | |
| $CH_3$-COONa. | $m$ $C_6H_4NO_2$-COOH. | HCOONa. | $m$ $C_6H_4NO_2$-COOH. | $CH_2Cl$-COONa. | $m$ $C_6H_4NO_2$-COOH. | HCOOK. | $m$ $C_6H_4NO_2$-COOH. |
| 0 | 3.424 | 0 | 3.424 | 0 | 3.424 | 0 | 3.424 |
| 1.009 | 5.144 | 0.843 | 4.776 | 1.375 | 4.075 | 1.025 | 4.742 |
| 2.484 | 7.932 | 2.102 | 6.380 | 3.426 | 4.876 | 2.563 | 6.446 |
| 5.027 | 12.61 | 4.196 | 8.616 | 6.839 | 5.861 | 5.124 | 8.551 |
| 10.07 | 20.77 | 8.410 | 11.90 | 13.710 | 7.264 | | |

## Solubility of Ortho Nitrobenzoic Acid in Aqueous Solutions of Dextrose, Sodium Chloride, and of Sodium Nitrate.

Original results in molecular quantities. (Hoffman and Langbeck, 1905).

| In Dextrose | | | In NaCl | | | In $NaNO_3$ | | |
|---|---|---|---|---|---|---|---|---|
| G. $C_6H_{12}O_6$ per 100 cc. Solution. | G. (o)$C_6H_4NO_2.COOH$ per 100 g. Solvent. At 25°. | At 35°. | G. NaCl. per 100 cc. Solution. | G. (o)$C_6H_4NO_2.COOH$ per 100 g. Solvent. At 25°. | At 35°. | G. $NaNO_3$ per 100 cc. Solution. | G. (o)$C_6H_4NO_2.COOH$ per 100 g. Solvent. At 25°. | At 35°. |
| 0.0 | 0.736 | 1.063 | 0.117 | 0.743 | 1.072 | 0.170 | 0.746 | 1.074 |
| 0.36 | 0.736 | 1.064 | 0.195 | 0.746 | 1.075 | 0.284 | 0.754 | 1.080 |
| 1.80 | 0.732 | 1.061 | 0.585 | 0.749 | 1.070 | 0.851 | 0.767 | 1.096 |
| 9.50 | 0.722 | 1.051 | 2.425 | 0.688 | 0.967 | 4.255 | 0.774 | 1.097 |
| 20.00 | 0.703 | 1.030 | 5.80 | 0.597 | 0.831 | 8.510 | 0.748 | 1.047 |

## Solubility of Para Nitro Benzoic Acid in Aqueous Solutions of Anilin and of Para Toluidin at 25°.

(Löwenherz — Z. physik. Chem. 25, 395, '98.)

### In Anilin.

| G. Mols. per Liter. | | Gms. per Liter. | |
|---|---|---|---|
| $C_6H_5NH_2$. | $C_6H_4.NO_2.COOH$. | $C_6H_5NH_2$. | $C_6H_4NO_2.COOH$. |
| 0.0 | 0.00164 | 0.0 | 0.274 |
| 0.01 | 0.00841 | 0.91 | 1.406 |
| 0.02 | 0.01379 | 1.82 | 2.304 |
| 0.04 | 0.02172 | 3.64 | 3.629 |
| 0.08 | 0.0347 | 7.29 | 5.798 |

### In *p*-Toluidin.

| G. Mols. per Liter. | | Gms. per Liter. | |
|---|---|---|---|
| $C_6H_4NH_2$-$CH_3$. | $C_6H_4NO_2.COOH$. | $C_6H_4NH_2$-$CH_3$. | $C_6H_4NO_2.COOH$. |
| 0.0 | 0.00164 | 0.0 | 0.274 |
| 0.01 | 0.0100 | 1.071 | 1.671 |
| 0.02 | 0.0174 | 2.142 | 2.902 |
| 0.03 | 0.0245 | 3.213 | 4.097 |

1000 cc. of sat. solution of para nitrobenzoic acid in aqueous 1 normal sodium para nitrobenzoate contain 0.0046 gm. mols. = 0.768 gm. $pC_6H_4NO_2COOH$ at 25°. (Sidgwick, 1910.)

## Distribution of Ortho Nitro Benzoic Acid at 25° Between: (Smith, 1921-1922.)

### Water and Chloroform.

| Millimols. o $NO_2C_6H_4COOH$ per liter of | | |
|---|---|---|
| $H_2O$ layer ($C_1$). | $CHCl_3$ layer ($C_2$). | $\frac{C_2}{C_1}$. |
| 2.775 | 0.45 | 0.162 |
| 5.55 | 1.55 | 0.279 |
| 6.60 | 2.05 | 0.310 |
| 8.65 | 3.35 | 0.388 |

### Water and Ethyl Ether.

| Millimols. o $NO_2C_6H_4COOH$ per liter of | | |
|---|---|---|
| $H_2O$ layer ($C_1$). | $(C_2H_5)_2O$ layer ($C_2$). | $\frac{C_2}{C_1}$. |
| 0.379 | 0.663 | 1.75 |
| 0.543 | 1.413 | 2.60 |
| 0.790 | 3.035 | 3.84 |
| 0.200 | 6.96 | 5.80 |
| 0.840 | 13.08 | 7.11 |

### Water and Xylene.

| Millimols. o $NO_2C_6H_4COOH$ per liter of | | |
|---|---|---|
| $H_2O$ layer ($C_1$). | $C_6H_4(CH_3)_2$ layer ($C_2$). | $\frac{C_2}{C_1}$. |
| 3.925 | 0.425 | 0.1080 |
| 5.70 | 0.55 | 0.0965 |
| 7.60 | 0.70 | 0.0920 |
| 10.30 | 0.40 | 0.0871 |

## Distribution of Meta Nitro Benzoic Acid at 25° Between: (Smith, 1921-1922.)

### Water and Chloroform.

| Millimols. o $NO_2C_6H_4COOH$ per liter of | | |
|---|---|---|
| $H_2O$ layer ($C_1$). | $CHCl_3$ layer ($C_2$). | $\frac{C_2}{C_1}$. |
| 0.854 | 0.600 | 1.23 |
| 0.675 | 0.975 | 1.44 |
| 0.955 | 1.655 | 1.71 |

### Water and Ethyl Ether.

| Millimols. m $NO_2C_6H_4COOH$ per liter of | | |
|---|---|---|
| $H_2O$ layer ($C_1$). | $(C_2H_5)_2O$ layer ($C_2$). | $\frac{C_2}{C_1}$. |
| 0.075 | 1.250 | 16.7 |
| 0.095 | 1.875 | 19.7 |
| 0.135 | 2.905 | 21.5 |
| 0.180 | 4.260 | 23.7 |
| 0.240 | 6.812 | 28.8 |

### Water and Xylene.

| Millimols. m $NO_2C_6H_4COOH$ per liter of | | |
|---|---|---|
| $H_2O$ layer ($C_1$). | $C_6H_4(CH_3)_2$ layer ($C_2$). | $\frac{C_2}{C_1}$. |
| 1.20 | 0.850 | 0.708 |
| 1.60 | 1.375 | 0.860 |
| 2.20 | 2.10 | 0.955 |
| 3.00 | 3.35 | 1.11 |

## Distribution of Ortho Nitrobenzoic Acid at 25° Between:

(Smith and White, 1929.)

### Water and Chloroform

| Gm. Mols. o $NO_2C_6H_4COOH$ per liter | |
|---|---|
| $H_2O$ layer | $CHCl_3$ layer |
| 0.00508 | 0.00185 |
| 0.00640 | 0.00251 |
| 0.00726 | 0.00297 |
| 0.00832 | 0.00357 |
| 0.01056 | 0.00528 |
| 0.01195 | 0.00634 |

### Water and Toluene

| Gm. Mols. o $NO_2C_6H_4COOH$ per liter | |
|---|---|
| $H_2O$ layer | $C_6H_5CH_3$ layer |
| 0.00572 | 0.000898 |
| 0.00660 | 0.00106 |
| 0.00748 | 0.00125 |
| 0.00869 | 0.00145 |
| 0.00990 | 0.00165 |
| 0.0130 | 0.00222 |

## Distribution of Meta Nitrobenzoic Acid at 25° Between:

(Smith and White, 1929.)

### Water and Chloroform

| Gm. Mols. m $NO_2C_6H_4COOH$ per liter | |
|---|---|
| $H_2O$ layer | $CHCl_3$ layer |
| 0.00370 | 0.0162 |
| 0.00469 | 0.0242 |
| 0.00515 | 0.0290 |
| 0.00607 | 0.0396 |
| 0.00713 | 0.0523 |
| 0.00779 | 0.0614 |

### Water and Toluene

| Gm. Mols. m $NO_2C_6H_4COOH$ per liter | |
|---|---|
| $H_2O$ layer | $C_6H_5CH_3$ layer |
| 0.00475 | 0.00748 |
| 0.00528 | 0.00880 |
| 0.00637 | 0.0121 |
| 0.00769 | 0.0167 |
| 0.00851 | 0.0196 |
| 0.00937 | 0.0231 |

## Distribution of Para Nitrobenzoic Acid at 25° Between:

(Smith and White, 1929.)

### Water and Chloroform

| Gm. Mols. p $NO_2C_6H_4COOH$ per liter | |
|---|---|
| $H_2O$ layer | $CHCl_3$ layer |
| 0.00070 | 0.00224 |
| 0.00084 | 0.00264 |
| 0.000924 | 0.00297 |
| 0.00106 | 0.00343 |
| 0.00125 | 0.00409 |
| 0.00145 | 0.00484 |

### Water and Toluene

| Gm. Mols. p $NO_2C_6H_4COOH$ per liter | |
|---|---|
| $H_2O$ layer | $C_6H_5CH_3$ layer |
| 0.000336 | 0.000336 |
| 0.000420 | 0.000448 |
| 0.000504 | 0.000530 |
| 0.000588 | 0.000630 |
| 0.000784 | 0.000812 |
| 0.00112 | 0.000980 |

## Distribution of Para Nitrobenzoic Acid at 25° Between:

(Smith, 1921-22.)

### Water and Chloroform

| Millimols p $NO_2.C_6H_4.COOH$ per liter of | | $\frac{C_2}{C_1}$ |
|---|---|---|
| $H_2O$ layer($C_1$) | $CHCl_3$ layer($C_2$) | |
| 0.364 | 0.400 | 1.1 |
| 0.525 | 0.687 | 1.31 |
| 0.75 | 1.175 | 1.57 |
| 1.05 | 1.975 | 1.88 |

### Water and Xylene

| Millimols p $NO_2.C_6H_4.COOH$ per liter of | | $\frac{C_2}{C_1}$ |
|---|---|---|
| $H_2O$ layer($C_1$) | $C_6H_4(CH_3)_2$ layer($C_1$) | |
| 0.3325 | 0.1750 | 0.458 |
| 0.681 | 0.4530 | 0.665 |
| 0.725 | 0.4625 | 0.638 |
| 0.962 | 0.7375 | 0.767 |
| 1.10 | 0.950 | 0.864 |

### Distribution Between Water and Benzene of : (de Szyszkowsky, 1915.)

| Ortho Nitro Benzoic Acid at : 25°. Gm. mols. $\times 10^{-3}$ $o(NO_2)C_6H_4CO\,OH$ per 1000 gms. | | Ortho Nitro Benzoic Acid at : 40°. Gm. mols. $\times 10^{-3}$ $o(NO_2)C_6H_4CO\,OH$ per 1000 gms. | | Meta Nitro Benzoic Acid at : 25°. Gm. mols. $\times 10^{-3}$ $m(NO_2)C_6H_4CO\,OH$ per 1000 gms. | | Meta Nitro Benzoic Acid at : 40°. Gm, mols. $\times 10^{-3}$ $m(NO_2)C_6H_4CO\,OH$ per 1000 gms. | |
|---|---|---|---|---|---|---|---|
| $H_2O$ layer. | $C_6H_6$ layer | $H_2O$ layer. | $C_6H_6$ layer. | $H_2O$ layer. | $C_6H_6$ layer. | $H_2O$ layer. | $C_6H_6$ layer |
| 5.164 | 1.068 | 6.692 | 2.140 | 2.370 | 3.385 | 2.290 | 3.374 |
| 7.614 | 1.960 | 10.06 | 3.567 | 3.022 | 4.836 | 3.23 | 5.354 |
| 8.496 | 2.227 | 12.91 | 5.052 | 4.794 | 9.657 | 5.522 | 11.15 |
| 9.109 | 2.460 | 16.21 | 6.90 | 6.944 | 17.20 | 8.310 | 20.53 |
| 11.23 | 3.324 | 30.76 | 16.40 | 9.356 | 27.86 | 12.28 | 38.37 |
| 14.03 | 4.587 | 44.10 | 27.86 | 12.01 | 44.26 | 19.56 | 82.43 |
| 21.03 | 8.174 | 56.89 | 41.02 | 16.34 | 75.50 | 27.04 | 147.2 |
| 25.12 | 10.70 | 65.89 | 51.22 | 22.40 | 135.90 | 36.23 | 254.6 |
| 40.72 | 23.05 | 71.91 | 58.80 | | | | |
| 43.83 | 26.50 | 76.54 | 64.25 | | | | |

### Solubility of Ortho Nitrobenzoic Acid in Several Alcohols.

(Timofeiew, 1894.)

| Solvent. | t°. | Gms. Acid per 100 Gms. Sat. Sol. | Gms. Acid per 100 Gms. Solvent. | Solvent. | t°. | Gms. Acid per 100 Gms Sat. Sol. | Gms. Acid per 100 Gms Solvent. |
|---|---|---|---|---|---|---|---|
| $CH_3OH$ | 0 | 36.2 | 56.6 | $C_3H_7OH$ | 0 | 17.7 | 21.5 |
| " | 22 | 52.2 | 109.1 | " | 22 | 31.2 | 45.5 |
| $C_2H_5OH$ | 0 | 23.3 | 30.4 | $(CH_3)_2CH.CH_2OH$ | 0 | 9.65 | 10.7 |
| " | 22 | 42.7 | 74.5 | | | | |

### Solubility of Ortho Nitrobenzoic Acid in Several Solvents.

(Collett and Lazzell, 1930.)

The determinations were made by the synthetic, sealed tube, method results were plotted and the following values read from the curves.

| t° | Gm. Mols. o $NO_2C_6H_4COOH$ per 100 gms. mols. sat. solution in: $(CH_3)_2CO$ | $(C_2H_5)_2O$ | $CHCl_3$ | $C_6H_6$ | $CCl_4$ |
|---|---|---|---|---|---|
| | | | | 0.15 | — |
| 10 | — | — | — | 0.24 | — |
| 20 | — | 7.0 | 0.7 | 0.35 | 0.01 |
| 30 | 24.44 | 11.2 | 1.0 | 0.55 | 0.10 |
| 40 | 26.7 | 15.5 | 1.2 | 0.70 | 0.20 |
| 50 | 30.1 | 20.2 | 1.6 | 0.80 | 0.25 |
| 60 | 34.4 | 25.0 | 1.9 | 1.2 | 0.35 |
| 70 | 37.3 | 30.2 | 2.7 | 2.2 | 0.40 |
| 80 | 41.7 | 35.5 | 4.4 | 4.3 | 0.45 |
| 90 | 46.8 | 41.3 | 7.7 | 9.4 | 0.5 |
| 100 | 52.8 | 47.7 | 14.8 | 24.3 | 0.6 |
| 110 | 59.8 | 55.5 | 31.0 | 46.7 | 3.9 |
| 120 | 68.2 | 64.6 | 49.6 | 68.5 | — |
| 130 | 77.7 | 76.4 | 69.3 | 87.5 | — |
| 140 | 89.4 | 89.2 | 88.1 | 100.0 | 100.0 |
| 147.7 (m.pt.) | 100.0 | 100.0 | 100.0 | | |

100 gms. sat. solution of o nitro benzoic acid in liquid ammonia contain 38 gms. o $NO_2C_6H_4COOH$ at (?) t°. (DeCarli, 1927.)

## Nitro**BENZOIC ACIDS** $C_6H_4.NO_2.COOH$. *o*, *m*, and *p*.

### Solubility in Several Solvents.

(de Connick, 1894; for solubility in $H_2O$, see also Paul; Vaubel; Löwenherz; Goldschmidt, 1898; Holleman, 1898; Noyes and Sammet, 1903; Sidgwick, 1910.)

| Solvent. | t°. | Gms. $C_6H_4.NO_2.COOH$ per 100 cc. Solvent. | | |
|---|---|---|---|---|
| | | Ortho. | Meta. | Para. |
| Water | 15 | 0.625 | 0.238 | 0.0213 |
| " | 20 | 0.682 (0.645G.) | 0.315 | 0.039 |
| " | 25 | 0.738 (0.779G.) | 0.341 | 0.028 (0.045) |
| " | 30 | 0.922 (0.922G.) | ... | ... |
| " | 35 | 1.141 (1.054) | 0.477 | 0.0419 |
| Methyl Alcohol | 10 | 42.72 | 47.34 | 9.6 |
| Ethyl Alcohol | 10 | 28.2 | 33.1 (11.7°) | 0.9 |
| " " (abs.) | 15 | 37.58* | 47.26* | 19.71* |
| " " (33 Vol.%) | 15 | 0.64 (11.8°) | 0.52 | 0.055 |
| Acetone | 10 | 41.5 | 41.5 | 4.54 |
| Benzene | 10 | 0.294 | 0.795 | 0.017 (12.5°) |
| Carbon Disulfide | 10 | 0.012 | 0.10 (8.5°) | 0.007 |
| Chloroform | 10 | 0.455 (11°) | 5.678 | 0.066 |
| " | 15 | 1.06† | 3.45† | 0.088† |
| " | 25 | 1.13† | 4.7† | 0.114† |
| " | 35 | 1.59† | 6.31† | 0.156† |
| Ether | 10 | 21.58 | 25.175 | 2.26 |
| Ligröin | 10 | trace | 0.013 | 0 |

* = Gms. acid per 100 cc. saturated solution. † = Gms. acid per 100 gms. solvent.

### Solubility of Meta Nitrobenzoic Acid in Several Alcohols.

(Timofeiew, 1894.)

| Solvent. | t°. | Gms. Acid per 100 Gms. | | Solvent. | t°. | Gms. Acid per 100 Gms. | |
|---|---|---|---|---|---|---|---|
| | | Sat. Sol. | Solvent. | | | Sat. Sol. | Solvent. |
| $CH_3OH$ | 0 | 41.9 | 72.2 | $C_2H_5OH$ | 21.5 | 43.9 | 89.8 |
| " | 19 | 53.7 | 116 | $C_3H_7OH$ | 0 | 24.1 | 31.8 |
| " | 21.5 | 57.1 | 133.1 | " | 19 | 31 | 45 |
| $C_2H_5OH$ | 0 | 33.6 | 50.6 | " | 21.5 | 32.5 | 48 |
| " | 19 | 42.3 | 73.2 | | | | |

### Solubility of Meta Nitrobenzoic Acid in Several Solvents.

(Collett and Lazzell, 1930.)

| t° | Gm. Mols. m $NO_2C_6H_4COOH$ per 100 gm. mols. sat. solution in: | | | | |
|---|---|---|---|---|---|
| | $(CH_3)_2CO$ | $(C_2H_5)_2O$ | $CHCl_3$ | $C_6H_6$ | $CCl_4$ |
| 0 | 11.0 | 7.0 | — | 0.3 | — |
| 10 | 15.2 | 9.5 | 2.3 | 0.42 | — |
| 20 | 19.3 | 12.1 | 2.9 | 0.55 | — |
| 30 | 23.4 | 14.7 | 3.7 | 0.80 | 0.14 |
| 40 | 27.1 | 17.5 | 4.7 | 1.4 | 0.23 |
| 50 | 31.9 | 20.7 | 6.3 | 2.2 | 0.40 |
| 60 | 36.1 | 24.2 | 8.8 | 3.3 | 0.70 |
| 70 | 41.0 | 28.8 | 12.7 | 5.7 | 0.85 |
| 80 | 46.3 | 34.8 | 18.3 | 10.0 | 1.3 |
| 90 | 52.2 | 42.2 | 26.8 | 18.4 | 2.4 |
| 100 | 58.5 | 50.1 | 38.6 | 30.8 | 5.0 |
| 110 | 65.6 | 58.8 | 53.0 | 47.8 | 13.0 |
| 120 | 76.1 | 69.2 | 67.0 | 63.8 | 53.7 |
| 130 | 87.2 | 83.4 | 81.8 | 81.7 | 79.1 |
| 142.4m. pt. | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 |

## Solubility of Para Nitrobenzoic Acid in Several Alcohols.

(Timofeiew, 1894.)

| Solvent. | t°. | Gms. Acid per 100 Gms. Sat. Sol. | Gms. Acid per 100 Gms. Solvent. |
|---|---|---|---|
| $CH_3OH$ | 18.5 | 3.45 | 3.57 |
| " | 21 | 3.75 | 3.90 |
| $C_2H_5OH$ | 18.5 | 3.25 | 3.36 |
| " | 19.5 | 3.16 | 3.26 |
| $C_2H_5OH$ | 21 | 3.22 | 3.32 |
| $C_3H_7OH$ | 18.5 | 2.12 | 2.17 |
| " | 19.5 | 1.85 | 1.90 |
| " | 21 | 2.29 | 2.34 |

## Solubility of Para Nitrobenzoic Acid in Several Solvents.

(Collett and Lazzell, 1930.)

| t° | Gm. Mols. p $NO_2C_6H_4COOH$ per 100 gm. mols. sat. solution in: $(CH_3)_2CO$ | $C_6H_6$ | $CCl_4$ |
|---|---|---|---|
| 10 | 1.9 | — | — |
| 20 | 2.2 | 0.01 | — |
| 30 | 2.7 | 0.08 | 0.01 |
| 40 | 3.3 | 0.17 | 0.07 |
| 50 | 3.8 | 0.24 | 0.13 |
| 60 | 4.7 | 0.33 | 0.20 |
| 70 | 5.5 | 0.41 | 0.25 |
| 80 | 6.6 | 0.50 | 0.30 |
| 90 | 7.9 | 0.60 | 0.36 |
| 100 | 9.6 | 0.70 | 0.40 |
| 110 | 11.4 | 0.85 | 0.48 |
| 120 | 13.2 | 1.1 | 0.54 |
| 130 | 16.3 | 1.3 | 0.66 |
| 140 | 19.3 | 1.6 | 0.70 |
| 150 | 22.9 | 2.2 | 0.90 |
| 160 | 27.0 | 3.5 | 1.5 |
| 170 | 31.5 | 6.2 | 2.1 |
| 180 | 35.9 | 10.7 | 2.8 |
| 190 | — | 17.5 | 4.6 |
| 200 | — | 26.3 | 7.3 |
| 210 | — | 46.4 | 12.7 |
| 239.9 m.pt. | 100. | 100. | 100.0 |

Determinations at temperatures above 200° and even as low as 170° in some cases, were impossible on account of violent explosions. These occurred when ether, chloroform or carbon tetrachloride were used as solvents.

## Solubility of Ortho, Meta and Para Nitro Benzoic Acid in Benzene and in *n* Heptane.

(Sidgwick and Ewbank, 1921 *a*.)

| Solvent. | Results for Ortho Nitro Benzoic Acid. t°. | Gms. *o* $NO_2C_6H_4CO\,OH$ per 100 gms. sat. sol. |
|---|---|---|
| Benzene.... | 128.3 | 81.0 |
| " .... | 113.0 | 50.25 |
| " .... | 105.8 | 28.32 |
| " .... | 90.5 | 10.0 |
| " .... | 78.6 | 5.03 |
| " .... | 63.0 | 2.1 |
| *n* Heptane.. | 135.0 | 1.37 |
| " .. | 130.5 | 1.37 (L) |
| " .. | 139.6 (tr.pt.) | |

(L) a second liquid layer separates.

| Results for Meta Nitro Benzoic Acid. t°. | Gms. *m* $NO_2C_6H_4CO\,OH$ per 100 gms. sat. sol. |
|---|---|
| 121.0 | 79.6 |
| 105.0 | 55.5 |
| 89.5 | 30.54 |
| 65.2 | 9.87 |
| 48.0 | 4.95 |
| 33.0 | 1.95 |
| 123.4 | 2.07 |
| 103.0 | 1.03 |
| 135.0 (tr. pt.) | |

| Results for Para Nitro Benzoic Acid. t°. | Gms. *p* $NO_2C_6H_4COOH$ per 100 gms. sat. sol. |
|---|---|
| 222.0 | 82.1 |
| 201.6 | 54.8 |
| 196.5 | 33.42 |
| 183.4 | 21.1 |
| 164.5 | 9.45 |
| — | — |
| 179.0 | 1.04 |
| — | |
| 234.0 (tr. pt.) | |

1000 gms. sat. solution of p nitro benzoic acid in dry ethyl ether contain 0.0413 gm. mol. $NO_2.C_6H_4COOH$ at 25°.

1000 gms. sat. solution of p Nitro benzoic acid in ethyl ether sat. with $H_2O$ contain 0.1071 gm. mol. $NO_2.C_6H_4COOH$ at 25°. (de Szyszkowski, 1928.)

### Influence of very Slight Traces of Water upon the Solubility of Ortho Nitro Benzoic Acid in Benzene and in Chloroform at 30°.5.

(Cohen and Miyake, 1926.)

| Results for Benzene. | | Results for Chloroform. | |
|---|---|---|---|
| Thousandths of a Per cent of $H_2O$ in $C_6H_6$. | Gms. *o* $NO_2C_6H_4COOH$ per 100 gms. sat. sol. | Thousandths of a Per cent of $H_2O$ in $CHCl_3$. | Gms. *o* $NO_2C_6H_4COOH$ per 100 gms. sat. sol. |
| 0.0..... | 0.35 | 0.0..... | 0.45 |
| 37.7..... | 0.43 | 25.6..... | 0.51–0.52 |
| 66.3..... | 0.49 | 130.2..... | 0.56 |
| 89.1..... | 0.49–0.50 | sat..... | 0.56 |
| sat..... | 0.50 | | |

### Solubility of *o* Nitro Benzoic Acid and of 1.3.5 Dinitro Benzoic Acid in Water and in Benzene at 25°. (de Szyszkowski, 1914-1915.)

| | Gm. mols. cmpd. per 1000 gms. sat. solution in | | |
|---|---|---|---|
| Compound. | Water | Dry Benzene. | Benzene sat. with $H_2O$. |
| *o* Nitro benzoic Acid.... | – | $1.984.10^{-2}$ | $2.687.10^{-2}$ |
| 1.3.5 Dinitro benzoic Ac.. | $6.344.10^{-3}(6.831.10^{-3})$ | $4.880.10^{-3}$ | $8.676.10^{-3}(9.135.10^{-3})$ |

1.3.5 dinitrobenzoic acid shows an exceptional tendency to supersaturation. The results in parentheses are for solutions in which the equilibrium was approached from above.

Results for the mutual solubility of Para Nitrobenzoic Acid and Para Toluic acid are given by Johnston and Jones, 1928.

Freezing-point data for mixtures of ortho nitrobenzoic acid and di methyl pyrone are given by Kendall, 1914a. Results for mixtures of meta nitrobenzoic acid and benzoic acid are given by Bakunin and Angrisani, 1915.

## Nitro SALICYLIC ACID $NO_2(5)C_6H_3COOH(1)OH(2).H_2O$.

### Solubility of 5.Nitro Salicylic Acid in Water.

(Chattaway and Curjel, 1926.)

Constant agitation in a thermostat was employed. The saturated solutions were analyzed by titration with 0.01 *n* Na OH

| t°. | Gms. $NO_2C_6H_3.OH.COOH$ per 100 gms $H_2O$. | Solid Phase. |
|---|---|---|
| 14.95... | 0.061 | $NO_2.C_6H_3OH.COOH.H_2O$ |
| 17.5.... | 0.064 | » |
| 20.5.... | 0.068 | » |
| 25.0.... | 0.078 | » |
| 29.0.... | 0.093 | » |
| 31.0.... | 0.103 | » |
| 33.0.... | 0.115 | » |
| 35.0.... | 0.125 | » |
| 36.6.... | 0.139 | » |
| 40.1... | 0.169 | $NO_2.C_6H_3OH.COOH.H_2O$ |
| 45.0... | 0.200 | $NO_2.C_6H_3OH.COOH$ |
| 50.1... | 0.228 | » |
| 55.2... | 0.273 | » |
| 60.0... | 0.325 | » |
| 65.0... | 0.391 | » |
| 72.0... | 0.501 | » |
| 74.1... | 0.528 | » |
| 99.5... | 1.505 | » |

The transition temperature is 42°.5.

## TRI NITRO PHENYL METHANE $C_6H_2(NO_2)_3CH_3$.

Freezing-point data for mixtures of trinitro phenyl methane and Sarcosine anhydride are given by Pfeiffer and Angern, 1926.

## CHLORO NITRO TOLUENE SULFONYL CHLORIDES $CH_3C_6H_2Cl(NO_2)SO_2Cl$.

Freezing-points of mixtures of the 2.4 and 2.6 chloro nitro compounds are given by Davies, 1921.

## TRI NITRO PHENYL METHYL NITRAMINE $C_6H_2(NO_2)_3.CH_3.N.NO_2$.

Freezing-point data are given for mixtures of Tri nitro phenyl methyl nitramine and:

| | |
|---|---|
| Nitro anilines(1) | Styphnic acid(1) |
| Nitro phenols(1) | Tri nitro cresol(1)(2) |
| Nitro toluene(1)(3) | Tri nitro toluene(4)(5) |
| Picric acid(1) | |

(1) Jefremow and Tichomirowa, 1926; (2) Jefremow and Tichomirowa, 1927; (3) Giua, 1914; (4) Giua, 1924; (5) Jefremow and Bogojawleuski, 1926.

## Trinitro**TOLUENE** 2,4,6 $C_6H_2^1.CH_3(NO_2)_3$.

100 gms. $H_2O$ dissolve 0.021 gm. $C_6H_2.CH_3(NO_2)_3$ at 15° and 0.164 gm. at 100°.
100 gms. alcohol dissolve 1.6 gms. $C_6H_2CH_3(NO_2)_3$ at 22° and 10 gms. at 58°.
(Copisarow, 1915.)

### Solubility of α or 2, 4, 6 Trinitro Toluene (TNT) in Water.

(Taylor and Rinkenbach, 1923; also quoted in full by Desvergnes, 1924.)

Commercial Grade I trinitrotoluene was purified by recrystallization from hot benzene and from hot 95 % alcohol. Its setting point was 80°.6. The saturated solutions were prepared in triplicate by shaking frequently, during several hours, mixtures which had been heated to a temperature higher than that of the determination and afterwards kept in a thermostat. In some cases equilibrium was approached from below instead of above. About 30 to 50 grams of the saturated solution were weighed in a wagon pipet, the solvent evaporated by means of a current of warm dry air and the residue weighed after drying to constant weight. The determinations were plotted and the results for regular intervals of temperature were read from the curve.

| t°. | Gms. $C_6H_2CH_3(NO_2)_3$ per 100 gms. $H_2O$. | t°. | Gms. $C_6H_2CH_3(NO_2)_3$ per 100 gms. $H_2O$. | t°. | Gms. $C_6H_2CH_3(NO_2)_3$ per 100 gms. $H_2O$. | t°. | Gms. $C_6H_2CH_3(NO_2)_3$ per 100 gms. $H_2O$. |
|---|---|---|---|---|---|---|---|
| 0.... | 0.0100 | 30.... | 0.0175 | 55.... | 0.0570 | 80.... | 0.1075 |
| 10.... | 0.0110 | 35.... | 0.0225 | 60.... | 0.0675 | 85.... | 0.1175 |
| 15.... | 0.0120 | 40.... | 0.0285 | 65.... | 0.0775 | 90.... | 0.1275 |
| 20.... | 0.0130 | 45.... | 0.0360 | 70.... | 0.0875 | 95.... | 0.1375 |
| 25.... | 0.0150 | 50.... | 0.0475 | 75.... | 0.0975 | 100.... | 0.1475 |

### Solubility of α or 2, 4, 6 Trinitro Toluene (TNT) in Pyridine.

(Taylor and Rinkenbach, 1923; also quoted by Desvergnes, 1924.)

As in the case of the solubility in aniline, a complex is formed with pyridine. It was found to have the composition $C_5H_5N.C_6H_2CH_3(NO_2)_3$ and m. pt. 40°-42°. The determinations were made in the same manner as described above. The approximate results obtained by the cooling curve method were corrected by means of accurate determinations of the saturation points of prepared mixtures. The authors' corrected values are as follows.

| t°. | Gms. $C_6H_2CH_3(NO_2)_3$ per 100 gms. $C_5H_5N$. | t°. | Gms. $C_6H_2CH_3(NO_2)_3$ per 100 gms. $C_5H_5N$. | t°. | Gms. $C_6H_2CH_3(NO_2)_3$ per 100 gms. $C_5H_5N$. |
|---|---|---|---|---|---|
| 20..... | 137 | 40..... | 255 | 60..... | 600 |
| 25..... | 158 | 45..... | 302 | 65..... | 833 |
| 30..... | 184 | 50..... | 370 | 70..... | 1250 |
| 35..... | 215 | 55..... | 462 | 75..... | 2460 |

## Solubility of α or 2, 4, 6 Trinitro Toluene (TNT) in Aniline.

(Taylor and Rinkenbach. 1923; also quoted by Desvergnes, 1924.)

A large number of approximate determinations were made by the cooling curve method and four accurate determinations were made by the crystal growth method. These latter were used as fixed points for correcting the approximate curve. In the following table the results, showing grams per 100 grams sat. solution, were read from the authors diagram and the results showing grams per 100 grams of aniline were taken from his corrected table.

| | Gms. $C_6H_2CH_3(NO_2)_3$ per 100 gms. | | | | Gms. $C_6H_2CH_3(NO_2)_3$ per 100 gms. | | |
|---|---|---|---|---|---|---|---|
| t°. | sat. sol. | $C_6H_5NH_2$. | Solid Phase. | t°. | sat. sol. | $C_6H_5NH_2$. | Solid Phase. |
| -6.0.. | 0.0 | 0.0 | $C_6H_5NH_2$ | 75..... | 48.0 | 92.3 | $C_6H_5NH_2.C_6H_2CH_3(NO_2)_3$ |
| 0... | 5.0 | 5.0 | $C_6H_5NH_2.C_6H_2CH_3(NO_2)_3$ | 80..... | 56.0 | 130 | » |
| 10... | 6.0 | 6.1 | » | 83.6m. pt. | 68.0 | – | » |
| 20... | 8.0 | 8.1 | » | 80..... | 80.0 | – | » |
| 25.. | 9.0 | 9.4 | » | 75..... | 86.0 | 595 | » |
| 30... | 10.0 | 11.4 | » | 70..... | 89.0 | 807 | » |
| 40... | 15.0 | 18.0 | » | 68 tr. pt.. | 90.0 | – | »+$C_6H_2CH_3(NO_2)_3$ |
| 50... | 22.0 | 28.7 | » | 70..... | 91.0 | 1043 | $C_6H_2CH_3(NO_2)_3$ |
| 60... | 30.0 | 44.5 | » | 75..... | 96.0 | 2074 | » |
| 70... | 42.0 | 69.3 | » | 80.6.... | 100.0 | ∞ | » |

## Solubility of α or 2, 4, 6 Trinitro Toluene (TNT) in Several Solvents

(Taylor and Rinkenbach, 1923; also quoted by Desvergnes, 1924.)

The determinations were made as deseribed on the previous page. The alcohol was 95.07 vol. % and $d_{15} = 0.816$. The results were plotted and the following values read from the curves.

| | Gms. $C_6H_2CH_3(NO_2)_3$ per 100 gms. of each solvent. | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| t°. | Acetone. | Benzene. | 95% $C_2H_5OH$. | $CCl_4$. | $CS_2$. | $CHCl_3$. | $(C_2H_5)_2O$. | Toluene. |
| 0..... | 57 | 13 | 0.65 | 0.20 | 0.14 | 6 | 1.73 | 28 |
| 5..... | 66 | 24 | 0.75 | 0.25 | 0.20 | 8.5 | 2.08 | 32 |
| 10..... | 78 | 36 | 0.85 | 0.40 | 0.26 | 11 | 2.45 | 38 |
| 15..... | 92 | 50 | 1.07 | 0.50 | 0.35 | 15 | 2.85 | 45 |
| 20..... | 109 | 67 | 1.23 | 0.65 | 0.48 | 19 | 3.29 | 55 |
| 25..... | 132 | 88 | 1.48 | 0.82 | 0.63 | 25 | 3.80 | 67 |
| 30..... | 156 | 113 | 1.80 | 1.01 | 0.85 | 32.5 | 4.56 | 84 |
| 35..... | 187 | 144 | 2.27 | 1.32 | 1.13 | 45 | – | 104 |
| 40..... | 228 | 180 | 2.92 | 1.75 | 1.53 | 66 | – | 130 |
| 45..... | 279 | 225 | 3.70 | 2.37 | 2.02 | 101 | – | 163 |
| 50..... | 346 | 284 | 4.61 | 3.23 | – | 150 | – | 208 |
| 55..... | 449 | 361 | 6.08 | 4.55 | – | 218 | – | 272 |
| 60..... | 600 | 478 | 8.30 | 6.90 | – | 302 | – | 367 |
| 65..... | 843 | 665 | 11.40 | 11.40 | – | 442 | – | 525 |
| 70..... | 1350 | 1024 | 15.15 | 17.34 | – | – | – | 826 |
| 75..... | 2678 | 2028 | 19 50 | 24.35 | – | – | – | 1685 |

100 gms. glycol diacetate ($CH_3CO O CH_2.CH_2 O OC.CH_3$, b. pt. 188°-189°.6) dissolve 44.4 gms. $C_6H_2CH_3(NO_2)_3$ at 25°.

(Taylor and Rinkenbach, 1926.)

## Solubility of Trinitro Toluene in Concentrated Solutions of Sulfuric Acid

(Hough, Savage and Van Marle, 1920.)

Gms. $C_6H_2CH_3(NO_2)_3$ per 100 gms. sat. solution in

| t°. | 70% $H_2SO_4$. | 75% $H_2SO_4$. | 80% $H_2SO_4$. | 85% $H_2SO_4$. | 90% $H_2SO_4$. | 95% $H_2SO_4$. | 100% $H_2SO_4$ |
|---|---|---|---|---|---|---|---|
| 0.... | – | 0.3 | 0.4 | 0.6 | 2.0 | 3.5 | 13.0 |
| 10.... | – | 0.3 | 0.45 | 0.75 | 2.2 | 4.0 | 13.5 |
| 20.... | – | 0.3 | 0.5 | 0.85 | 2.5 | 4.8 | 15.0 |
| 25.... | – | 0.32 | 0.55 | 0.95 | 2.6 | 5.2 | 15.5 |
| 30.... | – | 0.35 | 0.6 | 1.0 | 2.7 | 6.0 | 16.5 |
| 40.... | 0.2 | 0.4 | 0.65 | 1.3 | 3.0 | 7.0 | 18.0 |
| 50.... | 0.2 | 0.45 | 0.70 | 1.7 | 3.5 | 8.5 | 21.0 |
| 60... | 0.22 | 0 5 | 1.0 | 2.3 | 5.2 | 11.0 | 24.8 |
| 70.... | 0.35 | 0.7 | 1.6 | 3.3 | 7.0 | 13.5 | 29.0 |
| 80.... | 0.6 | 1.3 | 2.4 | 4.8 | 10.0 | 18.0 | 36.5 |

The above approximate values were read from the authors chart.

Freezing-point data are given for mixtures of Tri nitro toluene and:

Acenaphthene(32)(10)
Amino azo benzene(14a)
Amino aceto phenone(11)(12)
Aniline(28)
Anthracene(30)(23)
Azobenzene(17)
Azoxy benzene(15)
Benzoic acid(42)
Camphor(11)
Carbazole(32)(35)
Cinnamylidene aceto phenone(11)
Diethyl diphenyl urea(15)
Dimethyl amino azobenzene (17)
Dimethyl pyrone(41)
Dinitro benzene(10)(22)(20)(21)
Dinitro toluene(3)(8)(9)(10)(13)(39)(20)(22)
Diphenyl amine(10)
Fluoranthene(40)
Hexa nitro diphenyl amine(10)
Hydroquinol dimethyl ether(16)
Naphthalene(18)(27)
Naphthol(16)
" methyl ether(16)
Nitro benzene(19)
Nitro erythritol(38)
Nitro glycerol(33)(36)
Nitro mannitol(38)
Nitro naphthalene(39)
Nitro penta mannitol(38)
Nitro toluene(1)(2)(3)(8)(9)(10)(13)(5)(7)
Oxy benzaldehyde(31)
Oxy benzoic acid(6)
Phenylene diamines(29)
Picric acid(37)
Picryl chloride(18)
Pyrene(40)
Retene(23)
Salicylic acid(6)
Styphnic acid(24)
Tetra nitro methyl aniline(10)(25)(34)
Tri nitro cresol(26)
Tri nitro glycerol(36)(33)
Tri nitro phenol(11)(21)
Tri nitro phenyl methyl nitramine(14)
Tri nitro toluene(10)
Tri nitro xylene(4)(31)
Tri phenyl carbinol(28)
Fluorene(44)
Phenanthrene(43)

(1) Bell and Cordon, 1921; (2) Bell, Cordon, Spry and White, 1921; (3) Bell and Herty, Jr., 1919; (4) Bell and Sawyer, 1919; (5) Bell and Spry, 1921; (6) Crockford and Zurburg, 1930; (7) Bogoiaviensienski, 1918; (8) Giua, 1913; (9) Giua, 1914; (10) Giua, 1915; (11) Giua, 1916; (12) Giua, 1917; (13) Giua, 1920; (14) Giua, 1924; (14a) Giua, 1931; (15) Giua and Guastella, 1933; (16) Giua and Marcellino, 1920; (17) Giua and Reggiani, 1925; (18) Grimm, Gunther and Titus, 1931; (19) Hammick, Andrew and Hampson, 1932; (20) Hrynakowski, 1934; (21) Hrynakowski and Kapuscinski, 1933b; (22) Hrynakowski and Kapuscinski, 1934; (23) Jefremow, 1919; (24) Jefremow, 1919a; (25) Jefremow and Tichomirowa, 1926; (26) Jefremow and Tichomirowa, 1927; (27) Kremann, 1904, 1906; (28) Kremann, Hohl and Müller, II, 1921; (29) Kremann and Mauermann, 1923; (30) Kremann and Müller II, 1921; (31) Kremann and Pogantsch, 1923; (32) Kremann and Strzelba, 1921; (33) Kurita and Hagui, 1929; (34) Puschin and Marowitsch, 1914; (35) Rheinboldt, Henning and Kircheisen, 1925; (36) Tamburrini, 1927; (37) Taylor and Rinkenbach, 1923a; (38) Urbanski, 1933, 1934; (39) Wogrinz and Vari, 1919; (40) Shinomiya, 1940; (41) Kendall, 1914a; (42) Crockford and Hughs, 1930. (43) Kremann and Hofmeier, 1910; (44) Kremann, 1911.

## Methyl**PICRIC ACID** $C_6H(CH_3)(OH)(NO_2)_3$, 1.3.2.4.6.

Solubility in Aqueous Solutions at 25°. (Kendall, 1911.)

| Aq. Solvent. | Normality of Dissolved Methyl Picric Acid. | Aq. Solvent. | Normality of Dissolved Methyl Picric Acid. |
|---|---|---|---|
| Water | 0.0100 | 0.01975 *n o* Nitrobenzoic Acid | 0.0080 |
| " +Ligroin | 0.01019 | 0.00981 *n* Salicylic Acid | 0.01063 |
| " +Benzene | 0.01059 | 0.01393 *n* " " | 0.01072 |
| 0.00895 *n* HCl | 0.00641 | $H_2O$+Excess of Salicylic Acid | 0.02613* |
| 0.01593 *n* HCl | 0.00487 | | |
| 0.01013 *n* Picric Acid | 0.00702 | | |

* = normality of salicylic acid + methylpicric acid.

## TRI NITRO CRESOL $(NO_2)_3C_6H(CH_3)OH$.

Freezing-point data are given for mixtures of 2.4.6 tri nitro meta cresol and:

| | | |
|---|---|---|
| Acenaphthene(2) | Fluorene(2) | Pyrene(6) |
| Anthracene(2) | Naphthalene(7) | Retene(2) |
| Dinitrobenzene(2) | Phenanthrene(2) | Styphnic acid(4) |
| Fluoranthrene(6) | Picric acid(2)(5) | Tetra nitro methyl aniline(1)(3) |

(1) Jefremow and Tichomirowa, 1926; (2) Jefremow and Tichomirowa, 1927; (3)Jefremow and Tichomirowa, 1928;(4)Jefremow,1934;(5) Quist, 1924; (6) Shinomiya, 1940; (7) Saposchinikow and Gelvich, 1903, 1904.

## 1.2.4.6 Trinitr**ANISOLE** $(NO_2)_3C_6H_2.OCH_3$ 1.2.4.6.

Solubility in Several Solvents.

(Desvergnes, 1924.)

| Solvent. | t°. | Gms. $(NO_2)_3C_6H_2.OCH_3$ per 100 gms. solvent. | Solvent. | t°. | Gms. $(NO_2)_3C_6H_2.OCH_3$. per 100 gms. solvent. |
|---|---|---|---|---|---|
| Water..... | 15 | 0.020 | Benzene..... | 15 | 94.98 |
| » ..... | 50 | 0.137 | » ..... | 50 | 597.90 |
| » ..... | 100 | 0.389* | Chloroform ..... | 15 | 25.60 |
| Ethyl acetate..... | 15 | 89.44 | » ..... | 50 | 334.50 |
| » » ..... | 50 | 368.50 * | Ether (anhy.)..... | 15 | 4.183 |
| Acetone..... | 15 | 194.00 | » ..... | 34 | 7.86 |
| » ..... | 50 | 813.22 * | Pyridine..... | 15 | 40.35** |
| Ethyl alcohol (96°). | 15 | 2.31 | » ..... | 50 | 221.23 |
| » » | 50 | 17.79 * | $CS_2$ ..... | 15 | 0.426 |
| Ethyl alcohol (abs.). | 15 | 2.37 | » ..... | 36 | 1.11 |
| » » | 50 | 21.36 * | $CCl_4$..... | 15 | 0.511 |
| Methyl alcohol.... | 15 | 5.24 | » ..... | 50 | 3.65 |
| » » ..... | 50 | 27.65 * | Toluene..... | 15 | 86.49 |
| | | | » ..... | 50 | 421.53 |

* Partial saponification to nitrophenol and isopicric acid occurs.

** A picrate of pyridine having the formula $C_6H_2OH(NO_2)_3.2C_5H_5N$ is formed.

Freezing-point data are given for mixtures of 2.4.6 tri nitro anisole and:

Amino acetophenone(3)
Bromo naphthylamine(5)
Dimethyl naphthylamine(4)
Diphenyl amine(5)
Fluoranthene(7)
Naphthylamine(5)
Nitraniline(3)
Pyrene(7)
Picryl sulfide(2)
Tetra nitro methyl aniline(6)
Tri nitro phenetol(1)

(1) Brady and Horton, 1925; (2) Chaumeil and Thomas, 1923; (3) Giua, 1931; (4) Hertel and van Clef, 1928; (5) Hertel and Römer, 1930; (6) Shinomiya, 1940.

Results for mixtures of Ethoxy and Benzyloxy Nitro Anisoles are given by Robinson and Smith, 1926 and Oxford and Robinson, 1926.

TETRYL (2.4.6 Tri nitro phenyl methyl nitramine or tetra nitro methyl aniline) $(NO_2)_3C_6H_2N(NO_2)CH_3$.

### Solubility of Tetryl in Water.

(Taylor and Rinkenbach, 1923. The determinations are quoted in full by Desvergnes, 1924.)

The sample of tetryl used was purified by recrystallizing a good commercial product. Its setting point was 128°.72.

The saturated solutions were prepared in triplicate and equilibrium was approached from above and below. Constant agitation was not employed. The mixtures were shaken frequently for several hours and then allowed to settle two hours before a sample was removed for analysis. About 30-50 grams of the saturated solution were weighed in a wagon-pipet, the solvent evaporated, and the residue weighed after drying to constant weight. The determinations were plotted and the results for regular intervals of temperature were read from the curve.

| t°. | Gms. Tetryl per 100 gms. $H_2O$. | t°. | Gms. Tetryl per 100 gms. $H_2O$. | t°. | Gms. Tetryl per 100 gms. $H_2O$. |
|---|---|---|---|---|---|
| 0..... | 0.0050 | 35..... | 0.0094 | 70..... | 0.0535 |
| 5..... | 0.0058 | 40..... | 0.0110 | 75..... | 0.0663 |
| 10..... | 0.0065 | 45..... | 0.0140 | 80..... | 0.0810 |
| 15..... | 0.0072 | 50..... | 0.0195 | 85..... | 0.0980 |
| 20..... | 0.0075 | 55..... | 0.0270 | 90..... | 0.1220 |
| 25..... | 0.0080 | 60..... | 0.0350 | 95..... | 0.1518 |
| 30..... | 0.0085 | 65..... | 0.0440 | 100..... | 0.1842 |

### Solubility of Tetryl in Several Organic Solvents.

(Taylor and Rinkenbach, 1923. The results are quoted in full by Desvergnes, 1924.)

The same method was employed as that used for the determinations in water

| | Gms. Tetryl per 100 gms. of each Solvent. | | | | |
|---|---|---|---|---|---|
| t°. | 95 % alcohol | $CCl_4$. | $CHCl_3$. | $CS_2$. | $(C_2H_5)_2O$. |
| 0..... | 0.320 | 0.007 | 0.28 | 0.0090 | 0.188 |
| 5..... | 0.366 | 0.011 | 0.33 | 0.0120 | 0.273 |
| 10..... | 0.425 | 0.015 | 0.39 | 0.0146 | 0.330 |
| 15..... | 0.496 | 0.020 | 0.47 | 0.0177 | 0.377 |
| 20..... | 0.563 | 0.025 | 0.57 | 0.0208 | 0.418 |
| 25..... | 0.65 | 0.031 | 0.68 | 0.0244 | 0.457 |
| 30..... | 0.76 | 0.039 | 0.79 | 0.0296 | 0.493 |
| 35..... | 0.91 | 0.048 | 0.97 | 0.0392 | – |
| 40..... | 1.12 | 0.058 | 1.20 | 0.0557 | – |
| 45..... | 1.38 | 0.073 | 1.47 | 0.0940 | – |
| 50..... | 1.72 | 0.095 | 1.78 | – | – |
| 55..... | 2.13 | 0.124 | 2.23 | – | – |
| 60..... | 2.64 | 0.154 | 2.65 | – | – |
| 65..... | 3.33 | 0.193 | – | – | – |
| 70..... | 4.23 | 0.241 | – | – | – |
| 75..... | 5.33 | 0.297 | – | – | – |

100 gms. glycol diacetate ($CH_3.CO\ O.CH_2.CH_2.O\ OC.CH_3$, b. pt. 188°-189°.6) dissolve about 14.0 gms. tetryl at 20-25°. (Taylor and Rinkenbach, 1926.)

Freezing-point data are given for mixtures of Tetryl and:

| | | |
|---|---|---|
| Acenaphthene(3) | Fluorene(3) | Picric acid(4) |
| Chloro picrin(3) | Naphthalene(3) | Retene(3) |
| Di nitro aniline(3) | Nitro penta erythritol(5) | Tri nitro cresol(2)(3) |
| Di nitro benzene(2) | Nitro toluene(1) | Tri nitro toluene(1)(2)(4) |
| Di nitro phenol(2) | Phenanthrene(3) | Tri nitro xylene(3) |
| Di nitro toluene(2) | Picramide(3) | |

(1) Giua, 1914, 1915; (2) Jefremow and Tichomirowa, 1926; (3) Jefremow and Tichomirowa, 1928; (4) Taylor and Rinkenbach, 1923(a); (5) Urbanski, 1934.

DICHLORO TOLUENES $Cl_2.C_6H_3.CH_3$.

Freezing-point data for mixtures of the 2.4 and the 3.4 dichloro toluenes are given by Wahl, 1937.

BENZIMIDAZOLE $C_6H_4NHCH:N$.

Freezing-point data for mixtures of benzimidazole and pyramidon are given by Pfeiffer and Angern, 1926.

**BENZALDEHYDE** $C_6H_5CHO$.

100 gms. $H_2O$ dissolve 0.3 gm. $C_6H_5CHO$ at room temperature. (Flück inger, 1875; U.S.P.?)

100 gms. aqueous 0.4 normal sodium oleate solution (= 10.8 gm. Na oleate per 100 gms. solution) dissolve 5.8 gms. $C_6H_5CHO$ at 20°. (Smith, 1932.)

Mutual Solubility of Benzaldehyde and Glycerol.
(Mc Ewen, 1923.)

| t° of solution. | Gms. $C_6H_5CHO$ per 100 gms. sat. sol. | t° of solution. | Gms. $C_6H_5CHO$ per 100 gms. sat. sol. | t° of solution. | Gms. $C_6H_5CHO$ per 100 gms. sat. sol. |
|---|---|---|---|---|---|
| 67.5..... | 4.53 | 144.5..... | 26.63 | 152.5..... | 77.13 |
| 103.5..... | 7.74 | 160.3*.... | 49.22 | 127.5..... | 90.10 |
| 123.5..... | 12.42 | 160.7*.... | 55.29 | 107.5..... | 94.50 |
| 140.0..... | 23.87 | 159.5..... | 62.30 | 85.5..... | 97.02 |

* = Critical opalescence.

100 gms. sat. solution of benzaldehyde in liquid ammonia contain about 82 gms. $C_6H_5CHO$ at ? t°. (DeCarli, 1927.)

Freezing-point data are given for:

Benzaldehyde + Hydrocyanic acid (Peiker and Coffin, 1933.)
" + Nitric acid (Zukow and Kasatkin, 1909.)
" + Acetic acid anhydride (van der Beek, 1928.)
" + Tri chlor acetic acid (Kendall and Gibbons, 1915.)
" + Naphthols (Kremann and Zechner, 1925.)

*o* and *p* Chloro**FORMANILIDES** $Cl.C_6H_4NH.CHO$.

Freezing-point lowering data for mixtures of *o* and *p* chloroformanilide are given by King and Orton, 1911.

## Hydroxy**BENZALDEHYDES** *o*, *m* and *p* $C_6H_4OH.CHO$.

### Solubility of Each in Water.
(Sidgwick and Allott, 1923.)

The determinations were made by the synthetic, sealed tube, method. The concentrations are in terms of Wt. %, that is, the grams of *o*, *m* or *p* $C_6H_4$ OH.CHO per 100 gms. sat. sol.

The points at which a second liquid phase separates are marked L. The unstable points are marked *.

Results for Ortho Hydroxybenzaldehyde.

| t°. | Wt. %. |
|---|---|
| 85.8... | 1.68 L |
| 136.5... | 3.59 L |
| 154.0... | 5.34 L |
| ..... | .... |
| ..... | .... |
| ..... | .... |
| ..... | .... |
| 146.3... | 90.56 L |
| 118.3... | 93.20 L |
| 67.4... | 97.13 L |

Results for Meta Hydroxybenzaldehyde.

| t°. | Wt. %. |
|---|---|
| 43.0... | 2.73 |
| 57.8... | 9.38 |
| 58.9... | 11.0 |
| 63.5... | 19.2 L |
| 66.0... | 29.2 L |
| 66.1... | 31.9 L |
| 66.2... | 40.1 L |
| 65.6... | 43.4 |
| 62.4... | 53.9 |
| 60.4... | 65.1 |
| 71.2... | 83.3 |
| 81.1... | 84.0 |
| 106.0... | 100.0 |

Results for Para Hydroxybenzaldehyde.

| t°. | Wt. %. | t°. | Wt. %. |
|---|---|---|---|
| 30.5... | 1.33 | 62.8 tr. pt. | 27.4 |
| 52.0... | 4.34 | 63.8.... | 42.2 L |
| 59.2... | 8.32 | 62.8 tr. pt. | 46.2 |
| 61.9... | 13.2 | 63.0.... | 49.8 |
| 52.8... | 13.2*L | 61.8.... | 49.8*L |
| 62.8... | 20.7 | 64.1.... | 60.0 |
| 60.5... | 20.7*L | 69.3.... | 76.6 |
| 62.8... | 26.6 | 83.6.... | 88.8 |
| 62.4... | 26.6* | 116.0.... | 100.0 |

### Solubility of Ortho, Meta and Para Hydroxybenzaldehydes in Benzene.
(Sidgwick and Allott, 1923.)

The determinations were made by the synthetic, sealed tube method. Wt. % signifies the gms. of *o*, *m* or *p* $C_6H_4$ OH CH O per 100 gms. sat. sol. In case of the results marked B benzene separates as the solid phase.

Ortho.

| t°. | Wt. %. |
|---|---|
| 5.32.. | 0.0 B |
| 3.65.. | 4.35 B |
| 2.15.. | 8.23 B |
| 1.00.. | 10.90 B |
| —0.60.. | 15.0 B |
| —3.35.. | 20.4 B |
| —5.40.. | 25.0 B |
| —8.20.. | 31.4 B |
| 12.15.. | 39.2 B |

Meta.

| t°. | Wt. °/o. |
|---|---|
| 61.3.... | 6.29 |
| 67.1.... | 10.42 |
| 71.2.... | 16.6 |
| 75.7.... | 27.1 |
| 79.1.... | 40.0 |
| 82.4.... | 52.5 |
| 83.6.... | 59.5 |
| 89.8.... | 77.2 |
| 106.0.... | 100.0 |

Para.

| t°. | Wt. %. |
|---|---|
| 65.0. .. | 3.64 |
| 81.4.... | 11.09 |
| 84.1.... | 20.0 |
| 86.7.... | 31.0 |
| 89.5.... | 46.0 |
| 93.5.... | 59.8 |
| 100.6.... | 72.6 |
| 116.0.... | 100.0 |

## Ortho Hydroxy **BENZALDEHYDE** (Salicylaldehyde) o $OH.C_6H_4.CHO$.

Freezing-point data are given by Kremann and Zechner, 1925 for mixtures of Salicylaldehyde and each of the following compounds:
1.2.4 Dinitro phenol, Hydroquinone, α and β Naphthols, o Nitrophenol Picric acid and Pyrogallol.

Meta Hydroxy **BENZALDEHYDE** m $OH.C_6H_4CHO$.

Freezing-point data are given for mixtures of meta hydroxy benzaldehyde and:

| | | |
|---|---|---|
| Benzoic acid(1) | Naphthols(1) | Resorcinol(1) |
| Dinitro benzenes(1) | Nitro phenols(1)(5) | Salicylic acid(1) |
| Dinitro phenol(1)(5) | Phenol(1)(5) | Tri chlor acetic acid(3) |
| Dinitro toluene(1)(2) | Picric acid(1)(4) | Tri nitro toluene(1) |
| Hydroquinone(1) | Pyrogallol(1) | |

(1) Kremann and Pogantsch, 1923; (2) Kremann and Mauermann, 1922; (3) Kendall and Gibbons, 1915; (4) Rheimboldt, Henning and Kircheisen, 1925; (5) Kremann and Zechner, 1926.

Para Hydroxy **BENZALDEHYDE** p $.OH.C_6H_4CHO$.

Freezing-point data are given for:

| | |
|---|---|
| Para Hydroxy benzaldehyde | Dimethyl aniline (Schmidlin and Lang, 1912.) |
| " " " | Phenol " " " |
| " " " | Trichlor acetic acid(Kendall and Gibbons, 1915.) |

**BROMO NITRO TOLUENES** $BrNO_2C_6H_3CH_3$.

Freezing-point data for binary mixtures of the several isomeric bromo nitro toluenes are given by Coffee, 1926 and Geerling and Wibaut, 1934.

**NITRO BENZYL BROMIDE** p $C_6H_5CH.NO_2.Br$.

Freezing-point data for mixtures of p nitro benzyl bromide and α benzal doxime are given by Brady and Klein, 1927.

Nitro**BENZYL CHLORIDE** p $C_6H_5CHNO_2.Cl$.

SOLUBILITY IN SEVERAL SOLVENTS AT 25°. (v. Halban, 1913.)

| Solvent. | Gms. p $C_6H_5CH.NO_2Cl$ per 100 Gms. Solvent. | Sat. Sol. | Solvent. | Gms. p $C_6H_5CHNO_2.Cl$ per 100 Gms. Solvent. | Sat. Sol. |
|---|---|---|---|---|---|
| Methyl Alcohol | 8.87 | 8.15 | Nitrobenzene | 57.8 | 36.4 |
| Ethyl Alcohol | 7.10 | 6.63 | Ethylacetate | 57.8 | 36.4 |
| Propyl Alcohol | 5.70 | 5.39 | Ethylbenzoate | 43.3 | 30.2 |
| Amyl Alcohol | 4.88 | 4.65 | Ethylnitrite | 51.2 | 33.9 |
| Butyl Alcohol | 21.5 | 17.7 | Isoamylbromide | 12.5 | 10.4 |
| Acetic Acid | 18.1 | 15.3 | Brombenzene | 32 | 24.2 |
| Acetone | 107 | 51.7 | Chloroform | 47.6 | 32.3 |
| Acetophenone | 63.1 | 38.7 | Carbon Tetrachloride | 6.05 | 5.69 |
| Paraldehyde | 24.9 | 19.9 | Benzylchloride | 45.3 | 31.2 |
| Ether | 23.1 | 18.8 | α Bromnaphthaline | 31.7 | 23.4 |
| Acetonitrile | 96.6 | 49.1 | *n* Hexane | 1.30 | 1.28 |
| Nitromethane | 68.8 | 40.8 | Isopentane | 0.49 | 0.49 |
| *o* Nitrotoluene | 51.1 | 33.8 | Benzene | 69.7 | 37.4 |

### Solubility of Ortho, Meta, and Para Nitrobenzyl Chlorides, Each Separately in Several Solvents at 30°.

(McCombie, Scarborough and Smith, 1927.)

Weighed amounts of the solute and solvents were sealed in small bulbs and the temperature determined at which solution was complete. Five determinations were made in each case and these were plotted and the value for 30° obtained from the curve.

| Solvent | Gms. in each case per 100 gms. solvent: Ortho $C_7H_6O_2ClN$ | Meta $C_7H_6O_2ClN$ | Para $C_7H_6O_2ClN$ |
|---|---|---|---|
| Acetone | 433 | 644 | 126.8 |
| Benzene | 304 | — | 74.2 |
| Ethyl acetate | 257 | 394 | 69.7 |
| Nitro benzene | 217 | 326 | 68.2 |
| Ethyl benzoate | 171.3 | 266 | 51.2 |
| Ethyl alcohol | 26.3 | 30.4 | 8.2 |

Freezing-point data are given for mixtures of :

o and m nitro benzal chloride (Holleman, 1914.)
o, m and p nitro benzal chloride (Holleman, Vermeulen and de Mooy, 1914.)

## RICINOLEIC ACID $C_7H_6N_2O_2$ (m. pt. 295°).

100 gms. $H_2O$ dissolve 0.072 gm. $C_7H_6N_2O_2$ at 18° and 0.87 gm. at 100°. (Winterstein, Keller and Weinhagen, 1917.)

## BENZOIC ACID $C_6H_5COOH$.

### Solubility in Water.

(Bourgoin — Ann. chim. phys. [5] 15, 171, '78.)

| t°. | Grams. $C_6H_5COOH$ per 100 Gms. Water. | Solution. | t°. | Grams. $C_6H_5COOH$ per 100 Gms. Water. | Solution. |
|---|---|---|---|---|---|
| 0 | 0.170 | 0.170 | 40 | 0.555 | 0.551 |
| 10 | 0.210 | 0.209 | 50 | 0.775 | 0.768 |
| 20 | 0.290 | 0.289 | 60 | 1.155 | 1.142 |
| 25 | 0.345 | 0.343 | 80 | 2.715 | 2.643 |
| 30 | 0.410 | 0.408 | 100 | 5.875 | 5.549 |

100 grams saturated aqueous solution contain 0.25 gm. $C_6H_5COOH$ at 15°; 0.3426 gram at 25°; 0.353 gram at 26.4°; 0.667 gram at 45°; 5.875 gms. at 100°.

(Paul, 1894; Noyes and Chapin, 1898; Greenish and Smith, 1903; Hoffman and Langbeck, 1905; Lumsden, 1905; Philip, 1905; see also Alexejew, 1886; Ost, 1878; Vaubel, 1895; Freundlich and Seal, 1912.)

### Solubility of Mixtures of Liquid Benzoic Acid and Water.

(Alexejew.)

Determinations by "Synthetic Method," see Note, p. 292 Figures read from curve.

| t°. | Gms. $C_6H_5COOH$ per 100 Gms. Aq. Layer. | Benzoic Ac. Layer. | t°. | Gms. $C_6H_5COOH$ per 100 Gms. Aq. Layer. | Benzoic Ac. Layer. |
|---|---|---|---|---|---|
| 70 | 6 | 83 | 100 | 12.0 | 69.0 |
| 80 | 7.5 | 79.5 | 110 | 18.0 | 59.0 |
| 90 | 8.5 | 76 | 116 (crit. temp.) | 35 | |

## BENZOIC ACID

### Solubility of Benzoic Acid in Water.

| t° | Gms. mols. $C_6H_5COOH$ per liter. | Gms. $C_6H_5COOH$ per liter. | Authority. |
|---|---|---|---|
| 18..... | 0.0246 (prob. high) | 3.00 | (von Euler and Löwenhamm, 1916.) |
| 23.5... .. | – | 3.20 | (Schilow and Lepin, 1922.) |
| 25..... | 0.0276 | 3.37 | (Kendall and Andrews, 1921.) |
| 25..... | 0.02781 | 3.397 | (Larsson, 1926.) |
| 25..... | 0.0280 | 3.42 | (von Euler and Löwenhamm, 1916.) |

Data for the solubility of benzoic acid in water (determined by the synthetic method), agreeing satisfactorily with the results of Alexejew, are given by Sidgwick and Ewbank, 1921 *a*.

### Solubility of Benzoic Acid in Water.

(Ward and Cooper, 1930.)

| t° | Gms. $C_6H_5COOH$ per 100 gms. sat. sol. | Solid Phase | t° | Gms. $C_6H_5COOH$ per 100 gms. sat. sol. | Solid Phase |
|---|---|---|---|---|---|
| 24.6 | 0.334 | $C_6H_5COOH$ | 98.6 | 7.190 | 2 liquid layers |
| 25.15 | 0.3394(1) | " | 109.4 | 11.19 | " " |
| 42.4 | 0.628 | " | 116.1 | 20.61 | " " |
| 57.8 | 1.093 | " | 117.2crit.pt. | 32.34 | Homogeneous mixture |
| 74.1 | 2.067 | " | 116.3 | 46.37 | 2 liquid layers |
| 83.1 | 3.130 | " | 109.7 | 61.36 | " " |
| 88.3 | 3.966 | " | 101.1 | 69.01 | " " |
| 93.2 | 5.599 | " | 95.5 | 75.68 | $C_6H_5COOH$ |
| 89.7 | 5.599 | 2 liquid layers | 101.4 | 87.72 | " |
| 94.6 | 4.57 | Inv. pt. 73.5% Acid | 122.7 | 100.00 | " |
| 95.3 | 6.471 | $C_6H_5COOH$ | | | |

(1) Gms. per 100 cc. sat. solution. (Kilpatrick and Chase, 1931.)

### Solubility of Benzoic Acid in Water and in Ethyl Alcohol.

(Wright, 1927.)

| Solvent | Gms. $C_6H_5COOH$ per 100 gms. solvent at: 20° | 25° | 30° |
|---|---|---|---|
| Water | 0.345 | 0.343(1) | 0.42 |
| Aq. 50 Wt. % $C_2H_5OH$ | 16.95 | — | 25.2 |
| 100% $C_2H_5OH$ | 52.5 | — | 65.8 |

(1) Fuhner, 1924.

### Solubility of Benzoic Acid in Aqueous Solutions of Magnesium Sulfate at 25°.

(Randall and Failey, 1927.)

| "Ionic Strength" of aq. $MgSO_4$ solution | Gm. Mols. $C_6H_5COOH$ per liter sat. sol. | "Ionic Strength" of aq. $MgSO_4$ solution | Gm. Mols. $C_6H_5COOH$ per liter sat. sol. |
|---|---|---|---|
| 0.0 | 0.02793 | 0.2029 | 0.02796 |
| 0.02498 | 0.02828 | 0.4008 | 0.02723 |
| 0.04910 | 0.02837 | 0.7580 | 0.02578 |
| 0.1018 | 0.02818 | | |

## BENZOIC ACID

### Solubility of Benzoic Acid at 25° in Aqueous Solutions of :

(Kendall and Andrews, 1921.)

Hydrochloric Acid.

| Gm. mols. per liter | | Gm. mols. per liter | |
|---|---|---|---|
| HCl. | $C_6H_5COOH$. | HCl. | $C_6H_5COOH$. |
| 0.0 | 0.0276 | 3.308 | 0.0153 |
| 0.2828 | 0.0254 | 4.410 | 0.0140 |
| 0.6308 | 0.0235 | 5.238 | 0.0130 |
| 1.180 | 0.0211 | 7.172 | 0.0113 |
| 1.848 | 0.0185 | 9.522 | 0.0109 |

Nitric Acid.

| Gm. mols. per liter | | Gm. mols. per liter | |
|---|---|---|---|
| $HNO_3$. | $C_6H_5COOH$. | $HNO_3$. | $C_6H_5COOH$. |
| 0.0208 | 0.0272 | 1.019 | 0.0271 |
| 0.0807 | 0.0269 | 1.623 | 0.0272 |
| 0.1351 | 0.0268 | 2.430 | 0.0275 |
| 0.2021 | 0.0268 | 3.880 | 0.0277 |
| 0.5514 | 0.0270 | 4.784 | 0.0284 |

One liter of aqueous solution simultaneously saturated with benzoic and salicylic acids at 18° contains 0.0235 gm. mols. $C_6H_5COOH$ and 0.0116 gm. mols. $C_6H_4.OH.COOH$. 1.2.

(von Euler and Löwenhamm, 1916.)

### Solubility of Benzoic Acid in Aqueous Solutions of Acids at 25°.

(Drucker, 1929.)

Results for aqueous solutions of:

| Hydrochloric acid | | Nitric acid | | Sulfuric acid | | Picric acid | |
|---|---|---|---|---|---|---|---|
| Gm. Equiv. per liter | | Gm. Equiv. per liter | | Gm. Equiv. per liter | | Gm. Equiv. per liter | |
| HCl | $C_6H_5COOH$ | $HNO_3$ | $C_6H_5COOH$ | $H_2SO_4$ | $C_6H_5COOH$ | $C_6H_2OH(NO_2)_3$ | $C_6H_5COOH$ |
| 0.000 | 0.02805 | 0.00636 | 0.02709 | 0.00616 | 0.02755 | 0.00417 | 0.02675 |
| 0.00608 | 0.02709 | 0.02568 | 0.02635 | 0.02159 | 0.02689 | 0.00905 | 0.02679 |
| 0.02460 | 0.02586 | 0.05174 | 0.02631 | 0.03815 | 0.02579 | 0.01601 | 0.02819 |
| 0.04773 | 0.02536 | 0.08762 | 0.02625 | 0.1067 | 0.02558 | 0.04336 | 0.03174 |

### Solubility of Benzoic Acid in Aqueous Solutions of Sulfuric Acid at 25°.

(Hammett and Chapman, 1934.)

| Wt. % $H_2SO_4$ in Aq. Solvent | Gm. Mol. $C_6H_5COOH$ per 1000 gms. Aq. Solvent | Wt. % $H_2SO_4$ in Aq. Solvent | Gm. Mol. $C_6H_5COOH$ per 1000 gms. Aq. Solvent | Wt. % $H_2SO_4$ in Aq. Solvent | Gm. Mol. $C_6H_5COOH$ per 1000 gms. Aq. Solvent |
|---|---|---|---|---|---|
| 0.0 | 0.02760 (= 3.36 gm.) | 46.74 | 0.00517 | 70.37 | 0.01052 |
| 11.28 | 0.01610 | 48.72 | 0.00499 | 72.46 | 0.01371 |
| 19.79 | 0.01034 | 50.55 | 0.00500 | 74.59 | 0.01804 |
| 28.51 | 0.00708 | 52.76 | 0.00501 | 79.28 | 0.0593 |
| 35.82 | 0.00581 | 58.15 | 0.00541 | 81.75 | 0.0937 |
| 39.24 | 0.00530 | 60.83 | 0.00610 | 83.61 | 0.1020(1) |
| 41.90 | 0.00505 | 64.30 | 0.00681 | 85.13 | 0.1254(1) |
| 44.54 | 0.00496 | 67.38 | 0.00848 | 85.91 | 0.1356(1) |

(1) At a concentration of sulfuric acid above 80 percent the solid phase changes from benzoic acid to a compound with sulfuric having a molecular ratio of 1:1 or higher.

### Solubility of Benzoic Acid in Aqueous Solutions of Salts at 25°.

(Larsson, 1926.)

| Salt Solution. | Gms. mols. $C_6H_5COOH$. per liter. |
|---|---|
| 0.01605 *n* Sodium Oxalate... | 0.0370 |
| 0.0321 " " " ... | 0.0428 |
| 0.0642 " " " ... | 0.0505 |
| 0.025 *n* Sodium Succinate.. | 0.0608 |
| 0.05 " " " .. | 0.0857 |

| Salt Solution | Gms. mols. $C_6H_5COOH$. per liter. |
|---|---|
| 0.025 *n* Sodium Fumarate... | 0.0451 |
| 0.05 " " " ... | 0.0557 |
| 0.025 *n* Sodium (l) Malate .. | 0.0515 |
| 0.05 " " " ... | 0.0679 |
| 0.025 *n* Sodium (d) Tartrate . | 0 0417 |
| 0.05 " " " .. | 0.0507 |

## Solubility of Benzoic Acid in Aqueous Solutions of:

(Hoffman and Langbeck.)

### Potassium Chloride at 25°.

| Normality of Aq. KCl. | Gms. KCl. per Liter. | Dissolved $C_6H_5COOH$. Mol. Conc. | Wt. per cent. |
|---|---|---|---|
| 0.02 | 1.49 | $5.0254-10^{-4}$ | 0.339 |
| 0.05 | 3.73 | 4.9801 " | 0.333 |
| 0.20 | 14.92 | 4.7639 " | 0.322 |
| 0.50 | 37.30 | 4.3632 " | 0.295 |

### Potassium Nitrate at 25°.

| Normality of Aq. $KNO_3$ | Gms. $KNO_3$ per Liter. | Dissolved $C_6H_5COOH$. Mol. Conc. | Wt. per cent. |
|---|---|---|---|
| 0.02 | 2.02 | $5.0326-10^{-4}$ | 0.340 |
| 0.05 | 5.06 | 5.0421 " | 0.341 |
| 0.20 | 20.24 | 5.0297 " | 0.340 |
| 0.50 | 50.59 | 4.9400 " | 0.334 |
| 1.00 | 101.19 | 4.7646 " | 0.322 |

## Solubility of Benzoic Acid in Aqueous Solutions of:

(Hoffmann and Langbeck.)

### Sodium Chloride.

| Normality of Aq. NaCl. | Gms. NaCl per Liter. | Gms. $C_6H_5COOH$ per 100 Gms. Sol. at 25°. | at 45°. |
|---|---|---|---|
| 0.00 | 0.00 | 0.340 | 0.667 |
| 0.02 | 1.17 | 0.339 | 0.663 |
| 0.05 | 2.93 | 0.335 | 0.654 |
| 0.20. | 11.70 | 0.336 | 0.617 |
| 0.50 | 29.25 | 0.282 | 0.546 |
| 1.00 | 58.50 | ... | 0.449 |

### Sodium Nitrate.

| Normality of Aq. $NaNO_3$. | Gms. $NaNO_3$ per Liter. | Gms. $C_6H_5COOH$ per 100 Gms. Sol. at 25°. | at 45°. |
|---|---|---|---|
| 0.02 | 1.70 | 0.340 | 0.666 |
| 0.05 | 8.51 | 0.339 | 0.663 |
| 0.20 | 17.02 | 0.333 | 0.647 |
| 0.50 | 42.54 | 0.319 | 0.613 |
| 1.00 | 85.09 | 0.294 | ... |

## Solubility of Benzoic Acid in Aqueous Solutions of Salts.

(Herz and Hiebenthal, 1929.)

Results for aqueous solutions of:

### Potassium Chloride

| Gm. Equiv. per liter KCl | $C_6H_5COOH$ |
|---|---|
| 0.11 | 0.028 (= 3.4gm.) |
| 0.22 | 0.028 |
| 0.48 | 0.025 |
| 0.79 | 0.023 |
| 1.57 | 0.017 |
| 2.13 | 0.013 |
| 4.12* | 0.008 |

### Potassium Bromide

| Gm. Equiv. per liter KBr | $C_6H_5COOH$ |
|---|---|
| 0.00 | 0.028 |
| 0.20 | 0.028 |
| 0.35 | 0.027 |
| 0.66 | 0.025 |
| 1.18 | 0.022 |
| 2.09 | 0.018 |
| 4.68* | 0.009 |

### Sodium Chloride

| Gm. Equiv. per liter NaCl | $C_6H_5COOH$ |
|---|---|
| 0.20 | 0.027 |
| 0.35 | 0.026 |
| 0.98 | 0.019 |
| 1.96 | 0.011 |
| 3.03 | 0.009 |
| 3.80 | 0.006 |
| 5.44* | 0.003 |

### Magnesium Chloride

| Gm. Equiv. per liter $MgCl_2$ | $C_6H_5COOH$ |
|---|---|
| 0.19 | 0.027 |
| 0.39 | 0.025 |
| 0.71 | 0.022 |
| 1.38 | 0.018 |
| 2.41 | 0.012 |
| 4.45* | 0.05 |

* Solutions saturated with respect to both compounds.

## Solubility of Benzoic Acid in Aqueous Solutions of Sodium Benzoate at 0.2°.

(Larsson, 1931.)

| Gm. Mol. $C_6H_5COONa$ per liter aq. solvent | Gm. Mol. $C_6H_5COOH$ per liter sat. solution |
|---|---|
| 0.010 | 0.01257 |
| 0.250 | 0.01297 |
| 0.50 | 0.01416 |
| 1.00 | 0.01744 |

## Solubility of Benzoic Acid in Aqueous Solutions of Potassium Chloride and of Sodium Chloride with and Without the Presence of Sodium Benzoate at 18°.

(Larsson, 1930.)

| Composition of Aqueous Solvent in gm. mols. per liter | Gm. Mols. $C_6H_5COOH$ per liter sat. sol. | Composition of Aqueous Solvent in gm. mols. per liter | Gm. Mols. $C_6H_5COOH$ per liter sat. sol. |
|---|---|---|---|
| 0.5 NaCl | 0.01862 | 2.00 NaCl + 0.20 $C_6H_5COONa$ | 0.01124 |
| 1.0 " | 0.01551 | 2.00 " + 0.30 " | 0.01220 |
| 2.0 " | 0.01040 | 2.00 " + 0.40 " | 0.01320 |
| 3.0 " | 0.00700 | 2.50 " + 0.0103 " | 0.01963 |
| 0.1 KCl | 0.02204 | 0.500 " + 0.0103 " | 0.01782 |
| 0.25 " | 0.02112 | 1.00 " + 0.0103 " | 0.01453 |
| 0.50 " | 0.01953 | 2.00 " + 0.0103 " | 0.00974 |
| 1.00 " | 0.01684 | 3.00 " + 0.0103 " | 0.00655 |
| 2.00 " | 0.01282 | 0.20 KCl + 0.0103 " | 0.02099 |
| 1.00NaCl + 0.01 $C_6H_5COONa$ | 0.01450 | 0.25 " + 0.0103 " | 0.02009 |
| 1.00 " + 0.10 " | 0.01516 | 0.500 " + 0.0103 " | 0.01859 |
| 1.00 " + 0.20 " | 0.01612 | 0.500 " + 0.103 " | 0.01916 |
| 1.00 " + 0.40 " | 0.01837 | 1.00 " + 0.0103 " | 0.01594 |
| 2.00 " + 0.01 " | 0.00975 | 2.00 " + 0.0103 " | 0.01179 |
| 2.00 " + 0.10 " | 0.01039 | 3.00 " + 0.0103 " | 0.00873 |

## Solubility of Benzoic Acid in Aqueous Solutions of Sodium Benzoate Containing Increasing Amounts of Various Salts at 18°.

(Larsson, 1931a.)

The concentration of the sodium benzoate was 0.0103 gm. mols. per liter except in the two cases marked with an * where it was 0.10 gm. mol. per liter.

| Gm. Mol. salt per liter aq. solvent | Gm. Mols. $C_6H_5COOH$ per liter sat. sol. | Gm. Mol. salt per liter aq. solvent | Gm. Mols. $C_6H_5COOH$ per liter sat. sol. | Gm. Mol. salt per liter aq. solvent | Gm. Mols. $C_6H_5COOH$ per liter sat. sol. |
|---|---|---|---|---|---|
| 0.250 LiCl | 0.01921 | 0.100½($SrCl_2$) | 0.02072 | 0.325½($Ca(NO_3)_2$) | 0.02073 |
| 0.500 " | 0.01744 | 0.200 " | 0.02004 | 0.65 " | 0.01999 |
| 1.00 " | 0.01412 | 0.400 " | 0.01869 | 1.30 " | 0.01824 |
| 1.00 "* | 0.01461 | 2.00 " | 0.01088 | 0.50½($Sr(NO_3)_2$) | 0.02066 |
| 0.50 RbCl | 0.0195 | 0.250½($BaCl_2$) | 0.01963 | 1.00 " | 0.01968 |
| 1.00 " | 0.0167 | 0.500 " | 0.01821 | 2.00 " | 0.01767 |
| 0.50 CsCl | 0.0221 | 1.00 " | 0.01553 | 0.20½($Ba(NO_3)_2$) | 0.02134 |
| 1.00 " | 0.0222 | 2.00 " | 0.01144 | 0.60 " | 0.02040 |
| 0.20 KBr | 0.02192 | 3.00 " | 0.00813 | 0.10 $NaClO_4$ | 0.02200 |
| 0.50 " | 0.02041 | 0.208 $LiNO_3$ | 0.02076 | 0.20 " | 0.02166 |
| 1.00 " | 0.01832 | 0.417 " | 0.02017 | 0.50 " | 0.02070 |
| 0.20 KI | 0.0216 | 0.833 " | 0.01886 | 1.00 " | 0.01956 |
| 0.50 " | 0.0206 | 0.833 "* | 0.01957 | 0.25 $CHCl_2COONa$ | 0.0228 |
| 1.00 " | 0.0202 | 0.250 $NaNO_3$ | 0.02083 | 0.50 " | 0.02258 |
| 0.267½($MgCl_2$) | 0.02006 | 0.50 " | 0.02017 | 1.00 " | 0.02324 |
| 0.534 " | 0.01762 | 1.00 " | 0.01838 | 0.25 $CCl_3COONa$ | 0.02191 |
| 1.068 " | 0.01444 | 2.00 " | 0.01504 | 0.50 " | 0.02247 |
| 2.14 " | 0.00978 | 3.00 " | 0.01188 | 1.00 " | 0.02228 |
| 0.106½($CaCl_2$) | 0.02072 | 0.25 $KNO_3$ | 0.02119 | 0.20 $C_6H_5OSO_2Na$ | 0.02320 |
| 0.220 " | 0.02011 | 0.50 " | 0.02085 | 0.50 " | 0.02496 |
| 0.300 " | 0.01910 | 1.00 " | 0.02002 | 1.00 " | 0.02873 |
| 0.612 " | 0.01716 | 2.00 " | 0.01791 | 0.10 $C_{10}H_7OSO_2Na$ | 0.02562 |
| 0.844 " | 0.01592 | 3.00 " | 0.01656 | 0.20 " | 0.0311 |

# $C_7H_6O_2$

## BENZOIC ACID

### Solubility of Benzoic Acid in Aqueous Solutions of Sodium Benzoate Containing Increasing Amounts of Sodium and of Potassium Chloride.

(Larsson, 1931.)

The concentration of the aqueous sodium benzoate was 0.01 gm. mol. per liter in all cases.

| t° | Gm. Mols. Salt per liter aq. solvent | Gm. Mol. $C_6H_5COOH$ per liter sat. solution | t° | Gm. Mols. Salt per liter aq. solvent | Gm. Mol. $C_6H_5COOH$ per liter sat. solution |
|---|---|---|---|---|---|
| 0.2 | 0.0 NaCl | 0.01257 | 0.2 | 0.0 KCl | 0.01257 |
| " | 0.25 " | 0.01134 | " | 0.25 " | 0.01202 |
| " | 0.50 " | 0.01006 | " | 0.50 " | 0.01098 |
| " | 1.00 " | 0.00838 | " | 1.00 " | 0.00954 |
| " | 2.00 " | 0.00574 | " | 2.00 " | 0.00694 |
| " | 3.00 " | 0.00368 | " | 3.00 " | 0.00524 |
| 25.0 | 0.00 " | 0.02718 | 25.0 | 0.0 " | 0.02718 |
| " | 0.50 " | 0.0220 | " | 0.5 " | 0.02280 |
| " | 1.00 " | 0.01800 | " | 1.0 " | 0.01978 |
| " | 2.00 " | 0.01215 | " | 2.0 " | 0.01455 |

### Solubility of Benzoic Acid in Aqueous Salt Solutions at 35°.

(Goellen and Osol, 1937.)

| Gm. Mol. salt per liter aq. solvent | Gm. Mol. $C_6H_5COOH$ per liter sat. sol. | Gm. Mol. salt per liter aq. solvent | Gm. Mol. $C_6H_5COOH$ per liter sat. sol. | Gm. Mol. salt per liter aq. solvent | Gm. Mol. $C_6H_5COOH$ per liter sat. sol. |
|---|---|---|---|---|---|
| 0.0 (= $H_2O$ alone) | 0.03873 | 1.0 NaBr | 0.02661 | 0.4002 NaBr | 0.03477 |
| 0.1139 LiCl | 0.03578 | 1.5 " | 0.02278 | 0.5022 " | 0.03393 |
| 0.2068 " | 0.03426 | 2.0 " | 0.01927 | 1.0030 " | 0.03079 |
| 0.3022 " | 0.03278 | 0.1 KCl | 0.03672 | 1.5020 " | 0.02791 |
| 0.4016 " | 0.03151 | 0.2 " | 0.03527 | 2.0030 " | 0.02492 |
| 0.5040 " | 0.03042 | 0.3 " | 0.03450 | 0.1 KI | 0.03711 |
| 1.025 " | 0.02460 | 0.4 " | 0.03281 | 0.2 " | 0.03674 |
| 1.5217 " | 0.01996 | 0.5 " | 0.03173 | 0.3 " | 0.03624 |
| 2.0057 " | 0.01635 | 1.0 " | 0.02687 | 0.4 " | 0.03596 |
| 0.1 NaCl | 0.03595 | 1.5 " | 0.02313 | 0.5 " | 0.03527 |
| 0.2 " | 0.03435 | 2.0 " | 0.01979 | 1.0 " | 0.03335 |
| 0.3 " | 0.03324 | 0.1 KBr | 0.03663 | 1.5 " | 0.03139 |
| 0.4 " | 0.03179 | 0.2 " | 0.03560 | 2.0 " | 0.02922 |
| 0.5 " | 0.03057 | 0.3 " | 0.03468 | 0.05 $BaCl_2$ | 0.03645 |
| 1.0 " | 0.02494 | 0.4 " | 0.03381 | 0.1 " | 0.03489 |
| 1.5 " | 0.02020 | 0.5 " | 0.03288 | 0.15 " | 0.03362 |
| 2.0 " | 0.01644 | 1.0 " | 0.02906 | 0.2 " | 0.03241 |
| 0.1 NaBr | 0.03594 | 1.5 " | 0.02576 | 0.25 " | 0.03133 |
| 0.2 " | 0.03494 | 2.0 " | 0.02271 | 0.5 " | 0.02640 |
| 0.3 " | 0.03351 | 0.1044 NaBr | 0.03686 | 0.75 " | 0.02231 |
| 0.4 " | 0.03245 | 0.2051 " | 0.03604 | 1.00 " | 0.01896 |
| 0.5 " | 0.03115 | 0.3060 " | 0.03536 | | |

## BENZOIC ACID

### Solubility of Benzoic Acid in Aqueous Salt Solutions.

(Bhagwat and Dhar, 1929.)

| t° | Gm. Mol. (Equiv?) salt per liter | Gm. Mol. $C_6H_5COOH$ per liter |
|---|---|---|
| 17 | 0.0 | 0.0220 |
| " | 0.2536 $NaH_2PO_2$ | 0.0270 |
| " | 0.4227 " | 0.0300 |
| " | 0.5918 " | 0.0320 |
| " | 0.8454 " | 0.0350 |
| " | 0.4515 $NaH_2PO_3$ | 0.1710 |
| " | 0.7224 " | 0.2490 |
| " | 0.9030 " | 0.2930 |
| " | 1.8060 " | 0.4860 |
| " | 0.03117 $Na_3VO_4$ | 0.02350 |
| " | 0.06235 " | 0.02450 |
| " | 0.09345 " | 0.02600 |
| " | 0.1247 " | 0.02825 |
| 18 | 0.0 | 0.0226 |
| " | 0.1 $Na_2B_4O_7$ | 0.18 |
| " | 0.2 " | 0.38 |
| " | 0.3 " | 0.54 |
| " | 0.4 " | 0.71 |
| " | 0.0025 $K_2H_2Sb_2O_7$ | 0.0230 |
| " | 0.0050 " | 0.0234 |
| " | 0.0075 " | 0.0237 |
| " | 0.010 " | 0.0240 |
| " | 0.001375 $K_2TiO_3$ | 0.0230 |
| " | 0.00275 " | 0.0232 |
| " | 0.004125 " | 0.0234 |
| " | 0.000550 " | 0.0240 |
| 25 | 0.00 | 0.03147 |
| " | 0.02678 KF | 0.04076 |
| " | 0.04017 " | 0.04231 |
| 30 | 0.000 | 0.03204 |
| " | 0.4764 KF | 0.07442 |
| " | 0.7146 " | 0.09680 |
| " | 0.9528 " | 0.1168 |
| " | 1.191 " | 0.1361 |
| " | 0.06531 $K_2Cr_2O_7$ | 0.06295 |
| " | 0.0742 " | 0.06812 |
| " | 0.09457 " | 0.0774 |
| " | 0.1017 " | 0.08152 |
| " | 0.1076 " | 0.0841 |
| " | 0.1155 " | 0.08514 |
| " | 0.1704 " | 0.1145 |
| " | 0.02386 $K_2MoO_4$ | 0.04805 |
| " | 0.03284 " | 0.05365 |
| " | 0.03978 " | 0.05766 |
| " | 0.06568 " | 0.06967 |
| " | 0.07729 " | 0.08038 |
| " | 0.0253 $K_2WO_4$ | 0.04738 |
| " | 0.06072 " | 0.06046 |
| " | 0.08014 " | 0.06646 |
| " | 0.09050 " | 0.06935 |
| " | 0.09980 " | 0.07207 |
| " | 0.1012 " | 0.07287 |

### Solubility of Benzoic Acid in Aqueous Salt Solutions at 30°.

(Doosaj and Bhagwat, 1933; Bhagwat and Doosaj, 1933.)

In aqueous solutions of:

| Sodium Formate | | Sodium Acetate | | Sodium Citrate | | Sodium Salicylate | |
|---|---|---|---|---|---|---|---|
| Gms. per liter | | Gms. per liter | | Gms. per liter | | Gms. per liter | |
| HCOONa | $C_6H_5COOH$ | $CH_3COONa$ | $C_6H_5COOH$ | $C_3H_4OH(COONa)_3$ | $C_6H_5COOH$ | $C_6H_4OHCOONa$ | $C_6H_5COOH$ |
| 0.0 | 4.033 | 2.232 | 5.75 | 0.0 | 4.033 | 9.422 | 4.174 |
| 4.054 | 6.399 | 4.464 | 7.48 | 5.376 | 7.509 | 13.909 | 4.252 |
| 6.086 | 6.964 | 8.928 | 10.00 | 7.927 | 8.794 | 26.553 | 5.029 |
| 12.172 | 8.404 | 14.510 | 12.33 | 15.134 | 12.41 | 46.681 | 5.759 |
| 24.477 | 9.838 | 23.761 | 16.17 | 27.746 | 17.29 | 58.417 | 6.634 |
| 28.636 | 10.920 | 33.661 | 19.56 | 33.295 | 19.21 | 73.021 | 7.213 |
| 42.954 | 12.297 | 58.036 | 25.92 | 55.492 | 25.02 | 97.361 | 10.17 |
| 84.018 | 16.348 | 100.982 | 33.61 | 83.238 | 30.20 | 146.042 | 13.73 |
| 112.024 | 17.885 | 134.643 | 38.64 | 110.984 | 34.08 | 194.722 | 22.03 |
| 168.036 | 20.325 | 201.964 | 48.17 | 116.475 | 39.38 | 292.084 | 33.72 |

## Solubility of Benzoic Acid in Aqueous Solutions of Sodium Benzoate(?) Containing Increasing Amounts of Several Salts at 25°.

(Osol and Kilpatrick, 1933.)

The concentration of the aqueous sodium salt (Benzoate ?) solution) was 0.01 gm. mol. per liter in all cases.

| Gm. Mol. Salt. per liter aq. solvent | d. of sat. sol. | Gm. Mol. $C_6H_5COOH$ per liter sat. sol. | Gm. Mol. Salt per liter aq. solvent | d. of sat. sol. | Gm. Mol. $C_6H_5COOH$ per liter sat. sol. |
|---|---|---|---|---|---|
| 0.2 CsCl | 1.024 | 0.0256 | 0.2 p $C_6H_4CH_3OSO_2Na$ | 1.014 | 0.0305 |
| 0.5 " | 1.062 | 0.0242 | 0.5 " | 1.035 | 0.0378 |
| 1.0 " | 1.124 | 0.0223 | 1.0 " | 1.066 | 0.0620 |
| | | | 0.1 $C_{10}H_7OSO_2Na$ | 1.005 | 0.0313 |
| | | | 0.2 " | 1.013 | 0.0385 |

## Solubility of Benzoic Acid in Aqueous Solutions of Sodium Benzoate at 25°.

(Kolthoff and Bosch, 1932.)

| Gm. mols. $C_6H_5COONa$ per liter aq. solvent | Gm. Mols. $C_6H_5COOH$ per liter sat. sol. | Gm. Mols. $C_6H_5COONa$ per liter aq. solvent | Gm. Mols. $C_6H_5COOH$ per liter sat. sol. |
|---|---|---|---|
| 0.00(- $H_2O$ alone) | 0.02775 | 0.1 | 0.02757 |
| 0.01 | 0.02670 | 0.25 | 0.02934 |
| 0.02 | 0.02672 | 0.5 | 0.03398 |
| 0.03 | 0.02682 | 0.75 | 0.03933 |
| 0.05 | 0.02704 | 1.00 | 0.04623 |

## Solubility of Benzoic Acid in Aqueous 0.01 Normal Sodium Benzoate Solutions Containing Increasing Amounts of Various Salts at 25°.

(Kolthoff and Bosch, 1932.)

| Normality of added salt | Normality of dissolved $C_6H_5COOH$ | Normality of added salt | Normality of dissolved $C_6H_5COOH$ | Normality of added salt | Normality of of dissolved $C_6H_5COOH$ |
|---|---|---|---|---|---|
| 0.0 | 0.02676 | 0.05 $KNO_3$ | 0.02658 | 0.061 $CaCl_2$ | 0.02608 |
| 0.09 KCl | 0.02588 | 0.09 " | 0.02640 | 0.339 " | 0.02348 |
| 0.25 " | 0.02456 | 0.25 " | 0.02610 | 0.061 $SrCl_2$ | 0.02604 |
| 0.50 " | 0.02266 | 0.50 " | 0.02558 | 0.339 " | 0.02346 |
| 1.00 " | 0.01938 | 1.00 " | 0.02432 | 0.06 $Ba(NO_3)_2$ | 0.02650 |
| 0.09 NaCl | 0.02568 | 0.05 $NaNO_3$ | 0.02648 | 0.168 " | 0.02608 |
| 0.25 " | 0.02408 | 0.09 " | 0.02634 | 0.333 " | 0.02564 |
| 0.50 " | 0.02170 | 0.25 " | 0.02658 | 0.0608 $Ca(NO_3)_2$ | 0.02646 |
| 0.09 LiCl | 0.02558 | 0.50 " | 0.02452 | 0.169 " | 0.02624 |
| 0.25 " | 0.02395 | 0.05 $LiNO_3$ | 0.02642 | 0.338 " | 0.02582 |
| 0.50 " | 0.02160 | 0.09 " | 0.02618 | 0.08 $Sr(NO_3)_2$ | 0.02640 |
| 0.09 KBr | 0.02608 | 0.25 " | 0.02552 | 0.223 " | 0.02580 |
| 0.25 " | 0.02562 | 0.50 " | 0.02470 | 0.445 " | 0.02506 |
| 0.50 " | 0.02364 | 0.09 $NaClO_4$ | 0.02630 | 0.0597 $Mg(NO_3)_2$ | 0.02646 |
| 0.09 KI | 0.02642 | 0.25 " | 0.02590 | 0.166 " | 0.02594 |
| 0.50 " | 0.02528 | 0.50 " | 0.02550 | 0.333 " | 0.02534 |
| 0.06 $K_2SO_4$ | 0.02620 | 0.06 $BaCl_2$ | 0.02614 | 0. | |
| 0.333 " | 0.02412 | 0.50 " | 0.02376 | | |

# BENZOIC ACID

## Solubility of Benzoic Acid in Aqueous Salt Solutions at 18°.

(Larsson, 1927.)

| Gm. Mols. Salt per liter | Gm. Mols. $C_6H_5COOH$ per liter | Gm. Mols. Salt per liter | Gm. Mols. $C_6H_5COOH$ per liter | Gm. Mols. Salt per liter | Gm. Mols. $C_6H_5COOH$ per liter |
|---|---|---|---|---|---|
| 0.0 (= $H_2O$) | 0.02257 | 0.50 HCOONa | 0.0768 | 0.0546 $CH_2ClCOONa$ | 0.0283 |
| 0.5 NaCl | 0.0188 | 1.00 " | 0.0981 | 0.1092 " | 0.0310 |
| 1.0 " | 0.0158 | 0.05 $CH_3COONa$ | 0.0560 | 0.2730 " | 0.0368 |
| 0.025 HCOONa | 0.0310 | 0.10 " | 0.0782 | 0.546 " | 0.0428 |
| 0.05 " | 0.0377 | 0.20 " | 0.1121 | 1.092 " | 0.0507 |
| 0.10 " | 0.0451 | 0.25 " | 0.1261 | 0.50 $C_6H_5COONa$ | 0.0268 |
| 0.25 " | 0.0602 | 0.50 " | 0.1808 | 1.00 " | 0.0351 |
| | | 1.00 " | 0.2614 | | |

## Solubility of Benzoic Acid in Aqueous Sodium Acetate Solutions at 25°.

(Larsson, 1927.)

| Normality of aq. $CH_3COONa$ | Gm. Mols. $C_6H_5COOH$ per liter |
|---|---|
| 0.00 (= $H_2O$) | 0.0278 |
| 0.0493 | 0.0605 |
| 0.0985 | 0.0846 |

## Solubility of Benzoic Acid in Aqueous Solutions of Sodium Acetate, Formate, Butyrate, and Salicylate.

(Noyes and Chapin — Z. physik. Chem. 27, 443, '98; Philip — J. Ch. Soc. 87, 992, '05.)

| Grams Sodium Salt per Liter. | Grams $C_6H_5COOH$ per Liter of Solution in: | | | | | |
|---|---|---|---|---|---|---|
| | $CH_3COONa$. | | HCOONa. | | $C_3H_7COONa$. | $C_6H_4OH.COONa$. |
| | At 25°. | At 26.4°. | At 25°. | At 26.4°. | At 26.4°. | At 26.4°. |
| 0 | 3.41 | 3.53 | 3.41 | 3.53 | 3.53 | 3.53 |
| 1 | 4.65 | 4.75 | 4.25 | 4.35 | 4.50 | 3.62 |
| 2 | 5.70 | 5.85 | 4.75 | 4.85 | 5.40 | 3.70 |
| 3 | 6.70 | 6.90 | 5.20 | 5.30 | 6.15 | 3.80 |
| 4 | 7.60 | 7.85 | 5.60 | 5.70 | 6.90 | 3.87 |
| 6 | ... | ... | ... | ... | 8.40 | 4.00 |
| 8 | ... | ... | ... | ... | ... | 4.10 |

## Solubility of Benzoic Acid in Aqueous Solutions of Sodium Monochloracetate, Sodium Succinate and Potassium Formate at 25°.

(Philip and Garner, 1909.)

| In Aq. $CH_2ClCOONa$. Gms. per Liter Solution. | | In Aq. $(CH_2COONa)_2$. Gms. per Liter Solution. | | In Aq. HCOOK. Gms. per Liter Solution. | |
|---|---|---|---|---|---|
| $CH_2ClCOONa$. | $C_6H_5COOH$. | $(CH_2COONa)_2$. | $C_6H_5COOH$. | HCOOK. | $C_6H_5COOH$. |
| 0 | 3.38 | 0 | 3.38 | 0 | 3.38 |
| 1.375 | 3.684 | 1.182 | 4.087 | 1.025 | 4.087 |
| 3.426 | 4.026 | 2.932 | 5.112 | 2.563 | 4.734 |
| 6.839 | 4.417 | 5.848 | 6.564 | 5.124 | 5.503 |
| 13.710 | 4.929 | 11.730 | 9.005 | | |

The authors also obtained data for the solubility of benzoic acid in aqueous solutions of sodium acetate and sodium formate which agree closely with those quoted in the second table above.

## BENZOIC ACID

### Solubility of Benzoic Acid in Aqueous Solutions of Sodium Benzoate and of Potassium Benzoate at 18°.

(Larsson, 1930a.)

| Gm. Mols. Salt per liter | Gm. Mols. $C_6H_5COOH$ per liter | Gm. Mols. Salt per liter | Gm. Mols. $C_6H_5COOH$ per liter |
|---|---|---|---|
| 0.00 (= $H_2O$) | 0.02262 | 0.698 $C_6H_5COONa$ | 0.02946 |
| 0.01032 $C_6H_5COONa$ | 0.02185 | 0.930 " | 0.0341 |
| 0.1032 " | 0.02266 | 1.000 " | 0.0351 |
| 0.2325 " | 0.02383 | 0.0466 $C_6H_5COOK$ | 0.02243 |
| 0.465 " | 0.02638 | 0.0932 " | 0.02280 |
| 0.500 " | 0.0268 | 0.233 " | 0.02433 |

Results for the solubility of benzoic acid in saturated aqueous solutions of sodium benzene sulfonate, sodium xylene sulfonate and of sodium cymene sulfonate at various temperatures are given by Hauslick, 1935.

Results for equilibrium in the ternary system Benzoic Acid, Ortho Phthalic acid and water at various Temperatures are given by Ward and Cooper, 1930.

### Solubility of Benzoic Acid in Aqueous Solutions of Dioxane at 25°.

(Herz and Lorentz, 1929.)

| Vol percent Dioxane ($C_4H_8O_2$) in Aq. solvent | Gm. Equiv. $C_6H_5COOH$ per liter sat. sol. |
|---|---|
| 0.0 | 0.028 |
| 10.0 | 0.07 |
| 30.0 | 0.26 |
| 50.0 | 1.77 |
| 75.0 | 3.14 |
| 100.0 | 3.12 |

### Solubility of Benzoic Acid in Aqueous Solutions of Dextrose.

(Hoffman and Langbeck.)

| Normality of Aq. Dextrose. | Gms. $C_6H_{12}O_6$ per Liter. | Dissolved $C_6H_5COOH$ at 25°. Mol. Conc. | Dissolved $C_6H_5COOH$ at 25°. Weight Per Cent. | Dissolved $C_6H_5COOH$ at 45°. Mol. Conc. | Dissolved $C_6H_5COOH$ at 45°. Weight Per Cent. |
|---|---|---|---|---|---|
| 0.02 | 3.67 | $5.0322 \cdot 10^{-4}$ | 0.34 | $9.9088 \cdot 10^{-4}$ | 0.674 |
| 0.05 | 9.00 | 5.0403 " | 0.34 | 9.9328 " | 0.669 |
| 0.204 | 36.73 | 5.0303 " | 0.34 | 9.9323 " | 0.669 |
| 0.533 | 96.15 | 5.0321 " | 0.34 | 10.0101 " | 0.674 |
| 1.068 | 192.30 | 5.0443 " | 0.341 | 10.0369 " | 0.676 |

### Solubility of Benzoic Acid in Aqueous Solutions of Urea and of Thio Urea.

(Hoffman and Langbeck.)

| | Normality of Solution. | Gms. per Liter. | $C_6H_5COOH$ Dissolved at 25°. Mol. Conc. | Wt. per cent. |
|---|---|---|---|---|
| In Aqueous Urea | 0.10 | 6.01 $CO(NH_2)_2$ | $5.1876 \cdot 10^{-4}$ | 0.350 |
| In Aqueous Thio Urea | 0.20 | 15.23 $CS(NH_2)_2$ | 5.4994 " | 0.372 |

Data for the system benzoic acid, succinic acid nitrile and water are given by Schreinemakers, 1898, and for the system benzoic acid, phenol and water by Timmermanns, 1907.

100 cc. 90% ethyl alcohol dissolve 36.1 gms. $C_6H_5COOH$ at 15.5°. (Greenish & Smith, '03.)
100 cc. of a 1.0 *n* aqueous solution of aniline hydrochloride dissolve 0.537 gm. $C_6H_5COOH$ at 25°. (Sidgwick, 1910.)

SOLUBILITY OF BENZOIC ACID IN AQUEOUS SOLUTIONS OF ETHYL ALCOHOL AT 25°.
(Seidell, 1908, 1910.)

| Wt. % $C_2H_5OH$ in Solvent. | Sp. Gr. of Sat. Sol. | Gms. per 100 Gms. Sat. Sol. | | Wt. % $C_2H_5OH$ in Solvent. | Sp. Gr. of Sat. Sol. | Gms. per 100 Gms. Sat. Sol. | |
|---|---|---|---|---|---|---|---|
| | | $C_2H_5OH$. | $C_6H_5COOH$. | | | $C_2H_5OH$. | $C_6H_5COOH$. |
| 0 | 1 | 0 | 0.367 | 60 | 0.943 | 45.72 | 23.80 |
| 10 | 0.985 | 9.94 | 0.60 | 70 | 0.940 | 49.21 | 29.70 |
| 20 | 0.97c | 19.66 | 1.70 | 80 | 0.934 | 52.8 | 34 |
| 30 | 0.959 | 28.83 | 3.90 | 90 | 0.922 | 57.6 | 36 |
| 40 | 0.951 | 36.36 | 9.10 | 100 | 0.908 | 63.1 | 36.9 |
| 50 | 0.946 | 41.50 | 17 | | | | |

SOLUBILITY OF BENZOIC ACID IN AQUEOUS SOLUTIONS OF ETHYL ALCOHOL AT 25°.
(Halford, 1933.)

| Wt. % $C_2H_5OH$ in aq. solvent | Gms. $C_6H_5COOH$ per 100cc sat. sol. | Wt. % $C_2H_5OH$ in aq. solvent | Gms. $C_6H_5COOH$ per 100cc sat. sol. |
|---|---|---|---|
| 0.0 | 0.335 | 56.2 | 19.42 |
| 18.8 | 0.858 | 75.0 | 29.97 |
| 31.5 | 7.382 | 93.8 | 33.30 |

Data showing the effect of increasing amounts of several gum arabic sols upon the solubility of benzoic acid in water are given by Brintzinger and Beier, 1934.

DISTRIBUTION OF BENZOIC ACID AT 25° BETWEEN: (Smith, 1921-1922.)

Water and Chloroform.

| Millimols. $C_6H_5COOH$ per liter | | $\frac{C_2}{C_1}$. |
|---|---|---|
| $H_2O$ layer ($C_1$). | $CHCl_3$ layer ($C_2$). | |
| 0.2380 | 0.5625 | 2.36 |
| 0.3025 | 0.732 | 2.42 |
| 0.396 | 1.054 | 2.66 |
| 0.599 | 1.84 | 3.07 |
| 0.675 | 2.125 | 3.15 |
| 1.137 | 4.55 | 3.96 |

Water and Benzene.

| Millimols. $C_6H_5COOH$ per liter | | $\frac{C_2}{C_1}$. |
|---|---|---|
| $H_2O$ layer ($C_1$). | $C_6H_6$ layer ($C_2$). | |
| 0.8725 | 1.525 | 1.75 |
| 0.925 | 1.95 | 2.11 |
| 1.300 | 3.45 | 2.57 |
| 1.725 | 5.50 | 3.19 |
| 2.80 | 11.90 | 4.25 |
| 4.00 | 19.75 | 4.93 |

Data showing the influence of temperature upon the distribution of benzoic acid between water and benzene are given by Wosnessensky, 1923.

DISTRIBUTION OF BENZOIC ACID AT 25° BETWEEN: (Smith, 1921-1922.)

Water and Ethyl Ether.

| Millimols. $C_6H_5COOH$ per liter | | $\frac{(C_2)}{(C_1)}$. |
|---|---|---|
| $H_2O$ layer ($C_1$). | $(C_2H_5)_2O$ layer ($C_2$). | |
| 0.0375 | 0.9125 | 24.30 |
| 0.065 | 1.625 | 25.00 |
| 0.095 | 2.385 | 25.15 |
| 0.1575 | 4.8625 | 30.85 |
| 0.270 | 8.130 | 30.15 |
| 0.370 | 13.75 | 37.80 |

Water and Xylene.

| Millimols. $C_6H_5COOH$ per liter | | $\frac{C_2}{C_1}$. |
|---|---|---|
| $H_2O$ layer ($C_1$). | $C_6H_4(CH_3)_2$ layer ($C_2$). | |
| 0.737 | 0.678 | 0.92 |
| 0.794 | 0.819 | 1.03 |
| 0.842 | 0.865 | 1.03 |
| 1.568 | 2.90 | 1.85 |
| 4.19 | 17.4 | 4.15 |

### Distribution of Benzoic Acid at 25° Between:

(Smith and White, 1929.

Water and Chloroform

| Gm. Mols. $C_6H_5COOH$ per liter | |
|---|---|
| $H_2O$ layer | $CHCl_3$ layer |
| 0.00376 | 0.0354 |
| 0.00409 | 0.0414 |
| 0.00449 | 0.0475 |
| 0.00495 | 0.0559 |
| 0.00627 | 0.0845 |

Water and Toluene

| Gm. Mols. $C_6H_5COOH$ per liter | |
|---|---|
| $H_2O$ layer | $C_6H_5CH_3$ layer |
| 0.0057 | 0.0336 |
| 0.0072 | 0.0504 |
| 0.0096 | 0.0825 |
| 0.0120 | 0.1284 |
| 0.0135 | 0.1620 |

### Distribution of Benzoic Acid Between Water and Benzene:

At 10°. (Hendrixon, 1897.)

| Gms. $C_6H_5COOH$ per 100 cc. | |
|---|---|
| $H_2O$. Layer. | $C_6H_6$ Layer. |
| 0.0215 | 0.0725 |
| 0.0412 | 0.2363 |
| 0.0562 | 0.4422 |
| 0.0890 | 1.0889 |
| 0.1215 | 2.0272 |
| 0.1409 | 2.7426 |

At 20°. (Nernst, 1891.)

| Gms. $C_6H_5COOH$ per 100 cc. | |
|---|---|
| $H_2O$. Layer. | $C_6H_6$. Layer. |
| 0.0163 | 0.0535 |
| 0.0244 | 0.099 |
| 0.0452 | 0.273 |
| 0.0788 | 0.737 |
| 0.1500 | 2.42 |
| 0.2890 | 9.70 |

At 25°. (Farmer, 1903.)

| Gms. $C_6H_5COOH$ per 100 cc. | |
|---|---|
| $H_2O$ Layer. | $C_6H_6$ Layer. |
| 0.2002 (0.1885*) | 3.335 |
| 0.2012 (0.1891*) | 3.329 |
| 0.2020 (0.1902*) | 3.319 |

* = unionized.

At 40°. (Hendrixon, 1897.)

| Gms. $C_6H_5COOH$ per 100 cc. | |
|---|---|
| $H_2O$ Layer. | $C_6H_6$ Layer. |
| 0.0238 | 0.0714 |
| 0.0404 | 0.1637 |
| 0.0837 | 0.5740 |
| 0.1155 | 1.0269 |
| 0.1715 | 2.1420 |
| 0.2313 | 3.9167 |

### Distribution of Benzoic Acid Between Benzene and Aqueous Potassium Benzoate Solutions at 25°.

(Farmer, 1903.)

| Gms. Mols. $C_6H_5COOK$ per Liter Aq. Sol. | Gm. Mols. $C_6H_5COOH$ per Liter. | | Gms. $C_6H_5COOK$ per Liter Aq. Sol. | Gms. $C_6H_5COOH$ per liter. | |
|---|---|---|---|---|---|
| | Aq. Layer. | $C_6H_6$ Layer. | | Aq. Layer. | $C_6H_6$ Layer. |
| 0.0093 | 0.01587 | 0.2776 | 1.341 | 1.937 | 33.88 |
| 0.028 | 0.01597 | 0.2768 | 4.035 | 1.950 | 33.79 |
| 0.047 | 0.01603 | 0.2762 | 6.774 | 1.956 | 33.71 |

### Distribution of Benzoic Acid Between:

Water and Chloroform. (Hendrixon, 1897.)

At 10°.

| Gms. $C_6H_5COOH$ per 100 cc. | |
|---|---|
| $H_2O$ Layer. | $CHCl_3$ Layer. |
| 0.0208 | 0.0915 |
| 0.0269 | 0.1518 |
| 0.0327 | 0.2170 |
| 0.1057 | 2.0930 |

At 40°.

| Gms. $C_6H_5COOH$ per 100 cc. | |
|---|---|
| $H_2O$ Layer. | $CHCl_3$ Layer. |
| 0.0258 | 0.0880 |
| 0.0432 | 0.2059 |
| 0.0885 | 0.6961 |
| 0.1553 | 2.0435 |

Water and $CCl_4$. (Seidell, 1910a.)

At 25°.

| Gms. $C_6H_5COOH$ per 100 cc. | |
|---|---|
| $H_2O$ Layer. | $CCl_4$ Layer. |
| 0.134 | 0.830 |
| 0.291 | 4.41 |

The coefficient of distribution of benzoic acid between olive oil and water at 25° is given by Boeseken and Waterman (1911) as 12.6.

DISTRIBUTION OF BENZOIC ACID AT 19° BETWEEN : (Schilow and Lepin, 1922.)

| Water and Benzine. Gms. $C_6H_5COOH$ per 100 cc. | | Water and Benzene. Gms. $C_6H_5COOH$ per 100 cc. | | Water and Toluene. Gms. $C_6H_5COOH$ per 100 cc. | | Water and Xylene. Gms. $C_6H_5COOH$ per 100 cc. | |
|---|---|---|---|---|---|---|---|
| $H_2O$ layer. | Benzine layer. | $H_2O$ layer. | $C_6H_6$ layer. | $H_2O$ layer. | $C_6H_5CH_3$ layer. | $H_2O$ layer. | $C_6H_4(CH_3)_2$ layer. |
| 0.0568 | 0.0376 | 0.0718 | 0.538 | 0.0844 | 0.658 | 0.1135 | 1.043 |
| 0.1015 | 0.0996 | 0.1078 | 1.146 | 0.1285 | 1.590 | 0.1720 | 2.500 |
| 0.1628 | 0.254 | 0.1560 | 2.285 | 0.1580 | 2.388 | 0.2230 | 4.325 |
| 0.237 | 0.568 | 0.2260 | 4.84 | 0.1810 | 3.019 | 0.2825 | 6.170* |
| 0.329 | 0.998* | 0.329 | 9.70* | 0.2090 | 4.220 | | |
| | | | | 0.2755 | 6.970* | | |

| Water and Anisol. Gms. $C_6H_5COOH$ per 100 cc. | | Water and Amyl Ether. Gms. $C_6H_5COOH$ per 100 cc. | | Water and Ethyl Ether. Gms. $C_6H_5COOH$ per 100 cc. | | Water and Phenetol. Gms. $C_6H_5COOH$ per 100 cc. | |
|---|---|---|---|---|---|---|---|
| $H_2O$ layer. | $C_6H_5.OCH_3$ layer. | $H_2O$ layer. | $(C_5H_{11})_2O$ layer. | $H_2O$ layer. | $(C_2H_5)_2O$ layer. | $H_2O$ layer. | $C_6H_5.OC_2H_5$ layer. |
| 0.0627 | 0.942 | 0.0634 | 0.717 | 0.0765 | 5.38 | 0.1064 | 1.77 |
| 0.1020 | 1.965 | 0.119 | 1.508 | 0.158 | 11.45 | 0.1733 | 3.51 |
| 0.1495 | 3.520 | 0.179 | 2.390 | 0.190 | 14.05 | 0.3110 | 9.39* |
| 0.2330 | 7.600 | 0.341 | 5.17 | 0.268 | 21.20 | | |
| 0.2870 | 11.15* | | | 0.460 | 35.40* | | |

* Solid $C_6H_5COOH$ present.

DISTRIBUTION OF BENZOIC ACID AT 25° BETWEEN WATER AND ISO BUTYL ALCOHOL.
(de Kolossowsky and Bekturow, 1934; de Kolosowsky, Kulikow and Bekturow, 1935.)

| Gm. Mols. $C_6H_5COOH$ per liter | | $\frac{1}{2}$ | Gm. Mols. $C_6H_5COOH$ per liter | | $\frac{1}{2}$ |
|---|---|---|---|---|---|
| $H_2O$ layer(1) | Alcohol layer(2) | | $H_2O$ layer(1) | Alcohol layer(2) | |
| 0.00871 | 0.01989 | 0.438 | 0.0181 | 0.0763 | 0.237 |
| 0.00919 | 0.02250 | 0.408 | 0.0217 | 0.1235 | 0.170 |
| 0.0121 | 0.0351 | 0.345 | 0.0225 | 0.1505 | 0.150 |
| 0.0142 | 0.0446 | 0.318 | 0.0272 | 0.1929 | 0.141 |
| 0.0149 | 0.0525 | 0.284 | | | |

DISTRIBUTION OF BENZOIC ACID BETWEEN WATER AND BENZENE AND BETWEEN AQUEOUS 3.0 NORMAL SALT SOLUTIONS AND BENZENE AT 25°.
(Herz and Stanner, 1927.)

| Aq. 3.0n Solution of: | Gm. Mols. $C_6H_5COOH$ per liter | | Aq. 3.0n Solution of: | Gm. Mols. $C_6H_5COOH$ per liter | |
|---|---|---|---|---|---|
| | Aq. layer | $C_6H_6$ layer | | Aq. layer | $C_6H_6$ layer |
| $H_2O$ alone | 0.0078 | 0.0784 | NaBr | 0.0045 | 0.1112 |
| " | 0.0147 | 0.2265 | " | 0.0058 | 0.2202 |
| " | 0.0186 | 0.3696 | " | 0.0073 | 0.3328 |
| " | 0.0268 | 0.7059 | NaCl | 0.0034 | 0.1128 |
| KBr | 0.0054 | 0.1075 | " | 0.0056 | 0.3463 |
| " | 0.0075 | 0.2269 | " | 0.0074 | 0.5863 |
| " | 0.0081 | 0.3313 | NaI | 0.0067 | 0.1111 |
| KCl | 0.0043 | 0.1132 | " | 0.0082 | 0.1731 |
| " | 0.0055 | 0.2247 | " | 0.0097 | 0.2276 |
| " | 0.0068 | 0.3378 | $BaCl_2$ | 0.0045 | 0.1119 |
| KI | 0.0075 | 0.1146 | " | 0.0057 | 0.2216 |
| " | 0.0093 | 0.1724 | " | 0.0069 | 0.3358 |
| " | 0.0105 | 0.2709 | $SrCl_2$ | 0.0041 | 0.1112 |
| LiCl | 0.0040 | 0.1129 | " | 0.0055 | 0.2236 |
| " | 0.0078 | 0.5617 | " | 0.0062 | 0.3363 |

## Distribution of Benzoic Acid Between Water and Petroleum Ether.

(Grossfield and Miermeister, 1931.)

| cc 0.002 normal NaOH required for $C_6H_5COOH$ per 25 cc of: | | $\frac{1}{2}$ |
|---|---|---|
| $H_2O$ layer (1) | Pet. Ether layer (2) | |
| 45.0 | 18.9 | 2.38 |
| 87.1 | 67.7 | 1.29 |
| 110.1 | 109.8 | 1.00 |
| 142.0 | 174.5 | 0.81 |

## Solubility of Benzoic Acid in 90% Alcohol, in Ether and in Chloroform.

(Bourgoin.)

| Solvent. | t°. | Gms. $C_6H_5COOH$ per 100 Grams. Solvent. | Solution. |
|---|---|---|---|
| 90% Alcohol | 15 | 41.62 | 29.39 |
| Ether | 15 | 31.35 | 23.86 |
| Chloroform | 25 | 14.30 | 12.50 |

## Solubility of Benzoic Acid in Several Alcohols. (Timofeiew, 1894.)

| Alcohol. | t°. | Gms. $C_6H_5COOH$ per 100 Gms. Sat. Sol. | Solvent. | Alcohol. | t°. | Gms. $C_6H_5COOH$ per 100 Gms. Sat. Sol. | Solvent. |
|---|---|---|---|---|---|---|---|
| Methyl | −18 | 23.1 | 30 | Propyl | −18 | 14.5 | 16.9 |
| " | −13 | 24.3 | 32.1 | " | −13 | 15.7 | 18.5 |
| " | + 3 | 33.5 | 50.4 | " | + 3 | 23.1 | 30 |
| " | 19.2 | 40.1 | 67.1 | " | 19.2 | 28.2 | 39.3 |
| " | 23 | 41.7 | 71.5 | " | 23 | 29.8 | 42.3 |
| Ethyl | −18 | 20.3 | 25.4 | Isopropyl | 21.2 | 32.7 | 48.5 |
| " | −13 | 21.2 | 26.9 | Allyl | 21.2 | 25.1 | 33.4 |
| " | + 3 | 28.8 | 40.4 | Isobutyl | 0 | 15.3 | 18 |
| " | 19.2 | 34.4 | 52.4 | Isoamyl | 18 | 20.2 | 25.4 |
| " | 23 | 35.9 | 55.9 | Capryllic | 21.2 | 22.7 | 28.7 |
| | | | | Ethyleneglycol | 18 | 8 | 8.69 |

Additional data, agreeing closely with the above, are given by Timofeiew (1891) and Bourgoin (1878).

## Solubility of Benzoic Acid in Organic Solvents.

| Solvent. | t°. | Gms. $C_6H_5COOH$ per 100 cc. Sat. Sol. | Solvent. | t°. | $d_{25}$ of Sat. Solution. | Gms. $C_6H_5COOH$ per 100 Gms. Solvent. |
|---|---|---|---|---|---|---|
| Aq. 75% Acetic Acid | 14–16 | 10.92 (1) | Amyl Alcohol | 25 | 0.875 | 32.37 (6) |
| Benzene | 14–16 | 7.04 (1) | Amyl Acetate | 25 | 0.912 | 22 (6) |
| Carbon Disulfide | 14–16 | 4.24 (1) | Alcohol (Abs.) | 25 | 0.908 | 58.40 (6) |
| Carbon Tetrachloride | 14–16 | 4.50 (1) | Benzene | 25 | 0.897 | 12.23 (6) |
| " | 25 | 6.70 (2) | Chloroform | 25 | 1.456 | 15.14 (6) |
| " | 26 | 6.58 (3) | Carbon Tetrachloride | 25 | 1.564 | 4.18 (6) |
| Chloroform | 25 | 18.03 (2) | Carbon Disulfide | 25 | 1.282 | 4.82 (6) |
| Ethyl Ether | 14–16 | 39.80 (1) | Cumene | 25 | 0.906 | 8.59 (6) |
| Glycerol | 15–16 | 9.07*(4) | Ethyl Ether (Abs.) | 25 | ... | 46.74 (6) |
| Ligroin | 14–16 | 0.72 (1) | Ligroin | 25 | 0.720 | 1.75 (6) |
| Petroleum Ether † | 26 | 0.98 (3) | Naphtha | 25 | 0.730 | 2.65 (6) |
| Pentachlor Ethane | 25 | 10.92 (2) | Nitrobenzene | 25 | 1.225 | 10.05 (6) |
| Tetrachlor Ethane | 25 | 15.17 (2) | Toluene | 25 | 0.884 | 10.69 (6) |
| Tetrachlor Ethylene | 25 | 8.06 (2) | Spts. Turpentine | 25 | 0.859 | 5.09 (6) |
| Trichlor Ethylene | 25 | 13.62 (2) | Water | 25 | 1 | 0.368(6) |
| " | 15 | 6.44*(5) | Xylene | 25 | 0.877 | 9.71 (6) |
| Dichlor Ethylene | 15 | 9.67*(5) | | | | |

* = Gms. $C_6H_5COOH$ per 100 gms. sat. sol. † (B. pt. 30–70.)

(1) Bornwater and Holleman (1912); (2) Herz and Rathmann (1913); (3) de Jong (1909); (4) Ossendowski (1907); (5) Wester and Bruins (1914); (6) Seidell (1910).

One liter sat. sol. of benzoic acid in ethyl acetate contains 8 gms. at −6.5°, 37.7 gms. at 21.5° and 95.7 gms. at 75°. (Lloyd, 1918.)

One liter sat. solution of benzoic acid in benzene contain 77.6 gms. $C_6H_5COOH$ at 18°. One liter of solution in benzene simultaneously sat. with benzoic and salicylic acids contain 77.6 gms. $C_6H_5COOH$ + 25.0 gms. o $C_6H_5OHCOOH$ at 18°. (von Euler and Löwenhamme, 1916.)

### Solubility of Benzoic Acid in Several Solvents.

| Solvent. | t°. | Gms. $C_6H_5COOH$ per 100 gms. solvent. | Authority. |
|---|---|---|---|
| Benzene sat. with $H_2O$ | 25 | 12.7 | (de Szyszkowski, 1914-1915.) |
| Chloroform sat. with $H_2O$ | 25 | 15.6 | » |
| Carbon tetrachloride sat. with $H_2O$ | 25 | 4.3 | » |
| Benzine | 23.5 | 1.3 | (Schilow and Lepin, 1922.) |
| Ethyl ether | 23.5 | 27.5 | » |
| *p* Cymene (b. pt. 176°–176.5) | 25 | 6.5 | (Wheeler, 1920.) |
| Glycerol 86.5 % ($d_{20} = 1.2326$) | 20 | 1.4 | (Holm, 1921-1922.) |
| » 98.5 % ($d_{20} = 1.2645$) | 20 | 2.2 | » |
| Olive oil | 25 | 3.96 | (Verkade, 1921.) |
| Cotton seed oil | 25 | 4.22 | » |
| Peanut oil I | 25 | 4.78 | » |
| » » II | 25 | 3.98 | » |
| Cocoanut oil | 25 | 4.98 | » |
| Linseed oil | 25 | 4.27 | » |
| Castor oil | 25 | 14.70 | » |

### Solubility of Benzoic Acid in Several Solvents. (Mortimer, 1923.)

| t°. | Mols. $C_6H_5COOH$ per 100 mols. of saturated solution in: Acetone. | Acetophenone. | Phenol. | Nitrobenzene. | Toluene. | Carbon tetrachloride. |
|---|---|---|---|---|---|---|
| 0 | 15.8 | 8.3 | – | 4.4 | 3.2 | 1.7 |
| 20 | 20.5 | 14.4 | – | 9.2 | 5.8 | 4.2 |
| 40 | 26.9 | 23.6 | 16.9 | 16.3 | 13.6 | 9.4 |
| 60 | 36.2 | 35.9 | 28.2 | 27.6 | 24.3 | 20.0 |
| 80 | – | 51.6 | 44.2 | 43.4 | 40.0 | – |
| 100 | – | 71.6 | 67.0 | 66.0 | 64.6 | – |

### Solubility of Benzoic Acid in Benzene and in Toluene. (Chipman, 1924.)

An air jacketed test tube, provided with a stirrer and a thermometer, was used. Weighed amounts of benzoic acid and benzene were introduced and the mixture heated untill entirely homogeneous. It was then cooled with rapid stirring untill a cloud of minute crystals formed, and then warmed slowly with constant stirring untill the cloud of crystals disappeared. The results were plotted and the following values read from the smooth curve.

Results for Benzene.

| t°. | Gms. $C_6H_5COOH$ per 100 gm. sat. sol. |
|---|---|
| 4.3 (Eutec.) | 5.1 |
| 10.0 | 6.1 |
| 20.0 | 8.95 |
| 25.0 | 10.85 |
| 30.0 | 13.0 |
| 40.0 | 18.4 |
| 50.0 | 25.3 |
| 60 | 34.1 |
| 70 | 44.5 |
| 80 | 55.6 |
| 90 | 67.3 |
| 100 | 78.3 |
| 110 | 88.9 |
| 121.7 | 100.0 |

Results for Toluene.

| t°. | Gms. $C_6H_5COOH$ per 100 gms. sat. sol. |
|---|---|
| 0.0 | 4.44 |
| 10.0 | 5.6 |
| 20.0 | 8.0 |
| 25 | 9.6 |
| 30 | 11.5 |
| 40 | 16.2 |
| 50 | 22.3 |
| 60 | 30.2 |
| 70 | 39.7 |
| 80 | 50.7 |
| 90 | 62.8 |
| 100 | 75.1 |
| 110 | 86.8 |
| 121.7 | 100.0 |

A series of results for the solubility of benzoic acid in benzene, agreeing satisfactorily with the above, is given by Sidgwick and Ewbank, 1921 *a*. Individual determinations by von Euler and Löwenhamm, and by de Szyszkowski, 1914-1915, also agree with the above. The latter investigator also gives data for the simultaneous solubility of benzoic, salicylic and nitro benzoic acids in dry benzene and in benzene saturated with water.

## BENZOIC ACID

### Solubility of Benzoic Acid in Several Solvents.
(Chapas, 1930.)

| $t^\circ$ | Gm. Mol. $C_6H_5COOH$ per 100 gm. mol. sat. solution in: Chloro Benzene $C_6H_5Cl$ | Toluene $C_6H_5CH_3$ | o Chloro Toluene o $ClC_6H_4CH_3$ | p Chloro Toluene p $ClC_6H_4CH_3$ | Benzyl Chloride $C_6H_5CH_2Cl$ |
|---|---|---|---|---|---|
| 0 | 3.42 | 2.87 | 3.45 | — | — |
| 14.2 | 5.83 | 4.79(13°) | 5.89 | 5.41(12.5°) | 5.39(17.4°) |
| 25.0 | — | 7.61 | — | — | — |
| 31.8 | 11.12 | 9.67 | 11.05 | 10.92 | — |

### Solubility of Benzoic Acid in Several Solvents at 28°.
(Desai and Patel, 1935.)

| Solvent | Gm. Mols. $C_6H_5COOH$ per 1.0 gm. mol. sat. sol. | Solvent | Gm. Mols. $C_6H_5COOH$ per 1.0 gm. mols. sat. sol. |
|---|---|---|---|
| Water | 0.0005685 | Nitrobenzene | 0.1081 |
| Hexane | 0.01399 | Chloroform | 0.1495 |
| $CCl_4$ | 0.0593 | Methyl alcohol | 0.1689 |
| Benzene | 0.08191 | Ethyl alcohol | 0.1882 |
| Toluene | 0.08553 | n Propyl alcohol | 0.1810 |
| m Xylene | 0.0889 | n Butyl alcohol | 0.1968 |
| Chloro benzene | 0.1047 | Acetone | 0.2141 |

Results for the solubility of Benzoic Acid in binary mixtures of the above solvents are given in the form of a series of diagrams by Desai and Patel, 1935a.

### Solubility of Benzoic Acid in Several Solvents in the Dry State and Saturated with Water at 25°.
(v. Szyszkowski, 1928.)

| Solvent | Gm. Mols. $C_6H_5COOH$ per 1000 gms. sat. solution in: Dry Solvent | $H_2O$ saturated solvent |
|---|---|---|
| Ethyl Ether | 1.538 (186.1) | 2.771 (335.4) |
| Chloroform | 1.079 (130.6) | 1.108 (134.1) |
| Carbon tetra chloride | 0.3287 (39.77) | 0.3370 (40.78) |
| Benzene | 0.8946 (108.2) | 0.9222 (111.6) |

The figures in parentheses are calculated in grams $C_6H_5COOH$ per 1000 gms. sat. solution.

A method for the determination of the solubility of benzoic acid and other compounds in rubber is described by Morris, 1932.

SOLUBILITY OF BENZOIC ACID IN MIXTURES OF ORGANIC SOLVENTS AT 25°.
(Marden and Dover, 1916.)

| Mixtures of Ether + Chloroform. | | Mixtures of Acetone + Benzene. | | Mixtures of Ethyl Acetate + Benzene. | |
|---|---|---|---|---|---|
| % $CHCl_3$* in Solvent. | Gms. $C_6H_5COOH$ per 100 Gms. Solvent. | % $C_6H_6$ in Solvent. | Gms. $C_6H_5COOH$ per 100 Gms. Solvent. | % $C_6H_6$ in Solvent. | Gms. $C_6H_5COOH$ per 100 Gms. Solvent. |
| 100 | 38.4 | 100 | 11.6 | 100 | 11.6 |
| 90 | 34 | 90 | 18.3 | 90 | 14 |
| 80 | 30.1 | 80 | 24.1 | 80 | 16.5 |
| 70 | 26.6 | 70 | 31 | 70 | 20 |
| 60 | 23.2 | 60 | 33.5 | 60 | 20.4 |
| 50 | 20.8 | 50 | 37 | 50 | 22 |
| 40 | 18.6 | 40 | 42.2 | 40 | 23.9 |
| 30 | 16.8 | 30 | 47 | 30 | 26.5 |
| 20 | 15.6 | 20 | 49 | 20 | 29 |
| 10 | 15.2 | 10 | 51.3 | 10 | 28.2 |
| 0 | 15.0 | 0 | 55.6 | 0 | 41.2 |

* This is probably a mistake in the original and should be $\%(C_2H_5)_2O$ in Solvent.

SOLUBILITY OF BENZOIC ACID AT 25° IN MIXTURES OF:
(Herz and Levi, 1930.)

| Benzene and Heptane | | Carbon Tetra Chloride and Heptane | |
|---|---|---|---|
| Vol. % $C_6H_6$ in $C_6H_6 + C_6H_{16}$ mixture | Gm. Mols. $C_6H_5COOH$ per liter sat. sol. | Wt. % $CCl_4$ in $CCl_4 + C_6H_{16}$ mixture | Gm. Mols. $C_6H_5COOH$ per liter sat. sol. |
| 100 | 0.803 | 100 | 0.521 |
| 80 | 0.648 | 80 | 0.402 |
| 60 | 0.489 | 60 | 0.295 |
| 40 | 0.344 | 40 | 0.216 |
| 20 | 0.197 | 20 | 0.146 |
| 0 | 0.099 | 0 | 0.099 |

100 gms. sat. solution of Benzoic Acid in liquid ammonia contain 46 gms. $C_6H_5COOH$ at (?) t°. (DeCarli, 1927.)

Data for the reciprocal solubility of benzoic acid and sulfur are given by Hammick and Holt, 1927.

The critical solution temperature of mixtures of benzoic acid and α Chloro naphthalene is 95.5°.

The critical solution temperature of mixtures of benzoic acid and diphenyl is 87.5°. (Lecat, 1929.)

## CHLORO NITRO TOLUENES $CH_3C_6H_3ClNO_2$.

Freezing-point data for binary mixtures of the isomeric chloro nitro toluenes are given by Wibaut, 1913; Holleman and Vander Arend, 1909.

## NITRO BENZYL CHLORIDE o $C_6H_4(NO_2)CH_2Cl$.

Freezing-point data for mixtures of o nitro benzyl chloride and benzene are given by Schmidlin and Lang, 1912.

## BENZOIC ACID

Freezing-point data are given for mixtures of Benzoic Acid and:

Acetanilide(9)(29)
Acetamide(14)
Acetic acid(13)
Aniline(1)(16)
Antipyrine(17)(8)
Azobenzene(18)
Benzamide(14)
Benzanilide(29)
Benzene(5)(28)
Benzil(30)
Camphor(11)(12)
Chlor acetic acid(13)
Chloro benzoic acids. (3)(26)
p Cresol(7)
Di-anisal acetone(23)
Di chlor acetic acid(13)
Di nitro toluene(6)
Di phenyl amine (1a)
Erythritol(24)
Ethyl urethan(29)
Iodo benzoic acid(19)
Naphthalene(4)
Naphthol(2)
Naphthylamines(1a)(16)(21)
Nitro benzoic aldehyde(30)
p Nitro toluene(6)
m Oxybenzaldehyde(15)
Phenacetine(31)
Phenol(20)
Phenylene diamines(24)(16)(29)
o Phthalic acid(25)
Piperonal(30)
Resorcinol(9a)(27)(29)
Salicylic acid + Antipyrine(8)
Quinoline (1a)
Sarcosine anhydride(10)
Toluene(5) (229
p Toluidine(16)
Tri chlor acetic acid(13)
Tri nitro toluene(6)
Urea(16)(27)

(1) Baskov, 1913; (1a) Baskov, 1918; (2) Bartholemew and Wark, 1926; (3) Bornwater and Holleman, 1912; (4) Bernouilli and Sarasin, 1930; (5) Chipman, 1918; (6) Crockford and Hughes, 1930; (7) Da Silva, 1934; (8) Hrynakowski, 1934; (9) Hrynakowski and Adamanis, 1933(a); (9a) Hrynakowski and Adamanis 1933b; (10) Hammick and Howard, 1932; (11) Jefremow, 1913, 1915; (12) Jouniaux, 1912; (13) Kendall, 1914; (14) Kremann, Mauerman and Ostwald, 1923; (15) Kremann and Pogantsch, 1923; (16) Kremann, Weber and Zechner, 1925; (17) Kremann and Marktl, 1920; (18) Kremann and Zechner, 1925; (19) Lettre and Lehmann, 1938; (20) Moerman, 1933; (21) Milone and Rossingnolli, 1932; (22) Pfeiffer, Angern, Wang, Seydel and Quehl, 1930; (23) Pfeiffer, Goebel and Angern, 1925; (24) Puschin and Dezelic, 1938; (25) Ward and Cooper, 1930; (26) Hope and Riley, 1922; (27) Hrynakowski and Szmyt, 1935b; (28) Roloff, 1895; (29 Puschin and Wilowitsch, 1925; (30) Passerini, 1924; (31) Kitran, 1924.

### SALICYLIC ACID $C_6H_4.OH.COOH$ 1:2.

#### Solubility in Water.

(Average curve from the closely agreeing determinations of Walker and Wood, 1898; at 26.4°, Philip, 1905; at 25°, Paul, 1894; at 20°, Hoitsema, 1898a; Hoffman and Langbeck, 1905. For determinations not in good agreement with the following, see Alexejew, 1886; Bourgoin, 1878; Ost., 1878.)

| t°. | Gms. $C_6H_4.OH.COOH$ per Liter Solution. | t°. | Gms. $C_6H_4.OH.COOH$ per Liter Solution. | t°. | Gms. $C_6H_4.OH.COOH$ per Liter Solution. |
|---|---|---|---|---|---|
| 0 | 0.8 | 25 | 2.2 | 60 | 8.2 |
| 10 | 1.2 | 30 | 2.7 | 70 | 13.2 |
| 20 | 1.8 | 40 | 3.7 | 80 | 20.5 |
| | | 50 | 5.4 | | |

#### Solubility of Salicylic Acid in Water

(Savorro, 1914.)

| t°. | Gms. $C_6H_4.OH.COOH$ per 1000 Gms. Sat. Sol. | t°. | Gms. $C_6H_4.OH.COOH$ per 1000 Gms. Sat. Sol. | t°. | Gms. $C_6H_4.OH.COOH$ per 1000 Gms. Sat. Sol. |
|---|---|---|---|---|---|
| 0 | 1.24 | 35 | 3.51 | 70 | 13.70 |
| 5 | 1.29 | 40 | 4.16 | 75 | 17.55 |
| 10 | 1.35 | 45 | 4.89 | 80 | 22.08 |
| 15 | 1.84 | 50 | 6.38 | 85 | 27.92 |
| 20 | 2 | 55 | 7.44 | 90 | 37.35 |
| 25 | 2.48 | 60 | 9 | 95 | 50.48 |
| 30 | 2.98 | 65 | 10.94 | 100 | 75.07 |

### Solubility of Salicylic Acid (Liquid) in Water.

Determinations by Synthetic Method. See Note, p. 292 The original data in each case were plotted and the following figures read from the curves.

| t°. | (Alexejew.) Gms. $C_6H_4OHCOOH$ per 100 Gms. Aqueous Layer. | Salicylic Acid Layer. | t°. | (Flaschner and Rankin, 1910.) Gms. $C_6H_4OHCOOH$ per 100 Gms. Aqueous Layer. | Salicylic Acid Layer. |
|---|---|---|---|---|---|
| 60 | 7 | 68 | 60 | 4.5 | 68 |
| 70 | 8 | 64 | 70 | 6.5 | 62.5 |
| 80 | 12 | 58 | 80 | 10 | 54 |
| 90 | 19 | 49 | 85 | 15 | 46 |
| 95 crit. temp. | 32 | | 87 crit. temp. | 30° | |

Data for the melting-point curve of mixtures of solid salicylic acid and water are also given by Flaschner and Rankin.

### Equilibrium in the System Salicylic Acid and Water. (Bailey, 1925.)

The author obtained the following results which agree with those of Walker and Wood, 1898, up to 30° and are slightly higher, above this temperature. He points out that the determinations of Savorro, 1914, are probably two high. His values for the metastable region differ slightly from those of Flaschner and Rankin, 1910.

| t°. | Gms. $C_6H_4OH.COOH$ per 100 gms. sat. sol. |
|---|---|
| 10..... | 0.131 |
| 20..... | 0.184 |
| 30..... | 0.261 |
| 40..... | 0.395 |
| 50..... | 0.592 |
| 60..... | 0.864 |

Results for the Metastable Region.

| t°. | Gms. $C_6H_4OH.COOH$ per 100 gms. $H_2O$ layer. | Salicylic acid layer. |
|---|---|---|
| 60..... | 4.4 | 69.6 |
| 70..... | 6.5 | 64.6 |
| 80..... | 9.8 | 55.9 |
| 85..... | 15.0 | 46.0 |
| 87..... | 30.0 | 30.0 |

One liter of sat. solution of salicylic acid in water contains 1.71 gms., in 0.1 molar $H_3BO_3$ solution, 2.42 gms. and in 0.5 molar $H_3BO_3$ solution, 4.21 gms. $OHC_6H_4COOH$ at 18°. (Kolthoff, 1926.)

More recent determinations of the solubility of salicylic acid in water are as follows:

| t° | Gms. of $OHC_6H_4COOH$ per liter sat. sol. | t° | Gms. of $OHC_6H_4COOH$ per liter sat. sol. |
|---|---|---|---|
| 0 | 0.89 - 0.95* (2)(3) | 25 | 2.24 (5) |
| 14.5 | 1.667 (1) | 25 | 2.26 (8) |
| 18 | 1.72 (4) | 25 | 2.478 (1) |
| 20 | 2.2* (9) | 30 | 2.743 (1) |
| 25 | 2.21 - 2.26* (2)(3) | 30 | 3.1* (9) |
| 25 | 2.21 (6) | 40 | 3.93* (3) |
| 25 | 2.20 (7) | 50 | 5.77* (3) |
| | | 75 | 6.78* (3) |

* per 1000 gms. $H_2O$.

(1) Doosay and Bhagwat, 1933; (2) Cohen and Goedhart, 1931; (3) Cohen and Thonessen, 1932; (4) Kolthoff, 1927; (5) Herz and Hiebenthal, 1929; (6) Larsson, 1927; (7) Osol and Kilpatrick, 1933a; (8) Réyer, 1923; (9) Wright, 1927.

$C_7H_6O_3$

## SALICYLIC ACID

### Solubility of Salicylic Acid in Water.

(Sidgwick and Ewbank, 1921a.)

The determinations were made by the synthetic method.

| t° of solid - liquid equilibrium | Gms. of $OH.C_6H_4COOH$ per 100 gms. sat. solution | t° of solid - liquid equilibrium | Gms. of $OHC_6H_4.COOH$ per 100 gms. sat. solution |
|---|---|---|---|
| 50 | 0.557 | 106.7(89.1) | 34.02 |
| 56 | 0.717 | 107.2(86.4) | 48.18 |
| 80 | 2.026 | 109.5(67.0) | 65.4 |
| 97.9 | 5.27 | 119.5 | 80.0 |
| 101.4(77.3) | 8.02 | 131.8 | 89.75 |
| 105.6(87.2) | 16.82 | 159.0(m.pt.) | 100.00 |

The figures in parentheses are points on the liquid-liquid curve. The critical solution point of this curve is at approximately 90°, and 30 wt. percent salicylic acid.

### Solubility of Salicylic Acid in Aqueous Solutions of Acids at 25°.

(Kendall, 1911.)

| Acid. | Gms. per Liter. Acid. | | $C_6H_4OH.COOH$. |
|---|---|---|---|
| Water alone | 0 | | 2.257 |
| Acetic Acid | 37.52 | $CH_3COOH$ | 2.335 |
| " | 75.05 | " | 2.409 |
| " | 150.10 | " | 2.549 |
| " | 300.20 | " | 2.850 |
| Formic Acid | 2.38 | HCOOH | 2.114 |
| " | 4.59 | " | 2.035 |
| " | 11.05 | " | 2.114 |
| " | 21.17 | " | 2.035 |
| " | 28.76 | " | 2.049 |
| " | 57.53 | " | 2.066 |
| " | 115.07 | " | 2.121 |

| Acid. | Gms. per Liter. Acid. | | $C_6H_4OH.COOH$. |
|---|---|---|---|
| Formic Acid | 230.15 | HCOOH | 2.370 |
| " | 460.30 | " | 2.901 |
| Hydrochloric Acid | 0.653 | HCl | 1.781 |
| " | 1.302 | " | 1.710 |
| " | 4.558 | " | 1.677 |
| " | 9.117 | " | 1.649 |
| " | 18.235 | " | 1.551 |
| Malonic Acid | 3.253 | $CH_2(COOH)_2$ | 2.051 |
| " | 10.49 | " | 1.944 |
| " | 20.84 | " | 1.880 |
| Methyl Picric Acid | 2.28 | $C_7H_5O_7N_3$ | 2.115 |

### Solubility of Salicylic Acid in Aqueous Solutions of Hydrochloric Acid at 25°.

Results of Knox and Richards, 1919.

| Equiv. normality HCl. | Equiv. normality $C_6H_4OHCOOH$. | Equiv. normality HCl. | Equiv. normality $C_6H_4OHCOOH$. |
|---|---|---|---|
| 0.000 | 0.01613 | 7.311 | 0.00656 |
| 1.459 | 0.00982 | 8.738 | 0.00666 |
| 3.057 | 0.00822 | 10.20 | 0.00710 |
| 4.374 | 0.00715 | 11.50 | 0.00794 |
| 6.161 | 0.00654 | 12.20 | 0.00856 |

Results of Kendall and Andrews, 1921.

| Equiv. normality HCl. | Equiv. normality $C_6H_4OHCOOH$. | Equiv. normality HCl. | Equiv. normality $C_6H_4OHCOOH$. |
|---|---|---|---|
| 0.000 | 0.0162 | 3.308 | 0.00777 |
| 0.500 | 0.0112 | 4.410 | 0.00732 |
| 1.180 | 0.0101 | 7.172 | 0.00692 |
| 1.848 | 0.00912 | 9.522 | 0.00721 |
| 2.498 | 0.00834 | 11.73 | 0.00768 |

### Solubility of Salicylic Acid in Aqueous Solutions of Nitric Acid at 25°.

(Kendall and Andrews, 1921.)

| Normality of $HNO_3$. | Normality of $C_6H_4OHCOOH$. |
|---|---|
| 0.0109 | 0.0149 |
| 0.0420 | 0.0140 |
| 0.0807 | 0.0139 |

## Solubility of Salicylic Acid in Aqueous Salt Solutions at 25° and at 35°. (Hoffman and Langbeck, 1905?)

| Salt. | Normality of Salt Solution. | Gms. Salt per Liter. | $C_6H_4OH.COOH$ Dissolved at 25°. Gms. per 1000 Gms. Sat. Sol. | $C_6H_4OH.COOH$ Dissolved at 25°. Gm. Mol. Per cent. | $C_6H_4OH.COOH$ Dissolved at 35°. Gms. per 1000 Gms. Sat. Sol. | $C_6H_4OH.COOH$ Dissolved at 35°. Gm. Mol. Per cent. |
|---|---|---|---|---|---|---|
| KCl | 0.020 | 1.49 | 2.24 | $2.9216.10^{-4}$ | 3.23 | $4.2206.10^{-4}$ |
| " | 0.100 | 7.46 | 2.25 | 2.9377 " | 3.23 | 4.2203 " |
| " | 0.492 | 36.73 | 2.02 | 2.6321 " | 3.01 | 3.9268 " |
| " | 1.004 | 74.92 | 1.89 | 2.4759 " | 2.68 | 3.5003 " |
| $KNO_3$ | 0.020 | 2.02 | 2.25 | 3.9351 " | 3.25 | 4.2499 " |
| " | 0.100 | 10.12 | 2.30 | 3.0103 " | 3.32 | 4.3334 " |
| " | 0.504 | 51.10 | 2.38 | 3.1061 " | 3.38 | 4.4123 " |
| " | 1.004 | 101.60 | 2.39 | 3.1249 " | 3.36 | 4.3848 " |
| NaCl | 0.020 | 1.19 | 2.23 | 2.9110 " | 3.22 | 4.2062 " |
| " | 0.100 | 5.95 | 2.22 | 2.9027 " | 3.20 | 4.1806 " |
| " | 0.497 | 29.50 | 2 | 2.6128 " | 2.85 | 3.7171 " |
| " | 0.988 | 58.80 | 1.72 | 2.2487 " | 2.43 | 3.1596 " |

## Solubility of Salicylic Acid in Aqueous Salt Solutions at 25°.

(Herz and Hiebenthal, 1928.)

| Gms. per liter KCl | Gms. per liter $OHC_6H_4COOH$ | Gms. per liter KCl | Gms. per liter $OHC_6H_4COOH$ | Gms. per liter NaCl | Gms. per liter $OHC_6H_4COOH$ | Gms. per liter NaCl | Gms. per liter $OHC_6H_4COOH$ |
|---|---|---|---|---|---|---|---|
| 11 | 21.9 | 157 | 14.8 | 0.0 | 22.4 | 117 | 12.1 |
| 25 | 21.8 | 230 | 11.7 | 29 | 20.2 | 184 | 7.7 |
| 47 | 20.8 | 319* | 8.4 | 71 | 15.9 | 319* | 3.5 |
| 75 | 18.8 | | | | | | |

* An excess of salt was present.

## Solubility of Salicylic Acid in Aqueous Solutions of Sodium Salicylate(?) Containing Increasing Amounts of Several Salts at 25°.

(Osol and Kilpatrick, 1933a.)

The concentration of the aqueous sodium salt (Salicylate?) solution was 0.01 gm. mol. per liter in all cases.

| Gm. Mol. added salt per liter | d. of sat. sol. | Gm. Mol. of $OHC_6H_4COOH$ per liter sat. sol. | Gm. Mol. added salt per liter | d. of sat. sol. | Gm. Mol. of $OHC_6H_4COOH$ per liter sat. sol. |
|---|---|---|---|---|---|
| 0.2 KCl | 1.008 | 0.01353 | 0.472 $NaClO_4$ | 1.034 | 0.01400 |
| 0.5 " | 1.021 | 0.01252 | 0.500 " | 1.038 | 0.01396 |
| 1.0 " | 1.042 | 0.01096 | 1.00 " | 1.076 | 0.01338 |
| 1.5 " | 1.064 | 0.00945 | 1.103 " | 1.082 | 0.01332 |
| 2.0 " | 1.087 | 0.00833 | 1.863 " | 1.141 | 0.01215 |
| 0.2 NaCl | 1.005 | 0.01326 | 0.10 $C_6H_5SO_3Na$ | 1.005 | 0.01447 |
| 0.5 " | 1.018 | 0.01188 | 0.25 " | 1.015 | 0.01545 |
| 1.0 " | 1.039 | 0.00984 | 0.50 " | 1.033 | 0.01728 |
| 2.0 " | 1.076 | 0.06666 | 1.00 " | 1.070 | 0.02349 |
| 0.5 LiCl | 1.010 | 0.01194 | 0.2 $pCH_3C_6H_4SO_3Na$ | 1.014 | 0.01677 |
| 0.673 " | 1.014 | 0.01104 | 0.5 " | 1.032 | 0.02191 |
| 1.198 " | 1.025 | 0.00882 | 1.0 " | 1.066 | 0.03903 |
| 2.067 " | 1.047 | 0.00607 | 0.1 $C_{10}H_7SO_3Na$ | 1.005 | 0.01790 |
| 0.2 KBr | 1.014 | 0.01381 | 0.2 " | 1.010 | 0.02295 |
| 0.5 " | 1.038 | 0.01308 | | | |
| 1.0 " | 1.080 | 0.01185 | | | |

## Solubility of Salicylic Acid in Aqueous Salt Solutions at 25°.

(Larsson, 1927.)

Results for aqueous solutions of:

Sodium Formate

| Gms. per liter | |
|---|---|
| HCOONa | $OHC_6H_4COOH$ |
| 0.0 | 2.21 |
| 3.40 | 6.336 |
| 6.80 | 9.332 |

Sodium Acetate

| Gms. per liter | |
|---|---|
| $CH_3COONa$ | $OHC_6H_4COOH$ |
| 0.0 | 2.21 |
| 6.80 | 8.283 |
| 13.61 | 14.081 |

Sodium Chloro Acetate

| Gms. per liter | |
|---|---|
| $CH_2ClCOONa$ | $OHC_6H_4COOH$ |
| 0.0 | 2.21 |
| 5.82 | 4.142 |
| 11.65 | 5.329 |

## Solubility of Salicylic Acid in Aqueous Salt Solutions at 25°.

(Philip, 1905; Philip and Garner, 1909.)

In Aq. Sodium Acetate.

| Gms. per Liter. | |
|---|---|
| $CH_3COONa$. | $C_6H_4OHCOOH$. |
| 1.01 | 3.60 |
| 2.48 | 5.93 |
| 5.03 | 9.56 |
| 10.07 | 16.81 |

In Aq. Sodium Formate.

| Gms. per Liter. | |
|---|---|
| HCOONa. | $C_6H_4OHCOOH$. |
| 0.81 | 3.40 |
| 1.63 | 4.42 |
| 4.06 | 7.11 |
| 8.14 | 10.44 |

In Aq. Sodium Monochlor Acetate.

| Gms. per Liter. | |
|---|---|
| $CH_2ClCOONa$. | $C_6H_4OHCOOH$. |
| 1.38 | 2.83 |
| 3.43 | 3.58 |
| 6.84 | 4.64 |
| 13.71 | 6.17 |

In Aq. Sodium Succinate.

| Gms. per Liter. | |
|---|---|
| $C_2H_4(COONa)_2$. | $C_6H_4OHCOOH$. |
| 1.18 | 2.97 |
| 2.93 | 4.34 |
| 5.85 | 6.56 |
| 11.73 | 10.82 |

In Aq. Potassium Formate.

| Gms. per Liter. | |
|---|---|
| HCOOK. | $C_6H_4OHCOOH$. |
| 0 | 2.265 |
| 1.03 | 3.38 |
| 2.56 | 4.93 |
| 5.12 | 7.13 |

In Aq. Sodium Butyrate at 26.4°.

| Gms. per Liter. | |
|---|---|
| $C_3H_7COONa$. | $C_6H_4OHCOOH$. |
| 1 | 3.3 |
| 2 | 4.5 |
| 4 | 6.85 |
| 5 | 8.1 |

One liter of 1 normal aqueous sodium salicylate solution dissolves 4.97 gms. salicylic acid at 25°.

(Sidgwick, 1910.)

## Solubility of Salicylic Acid in Aqueous Salt Solutions:

(Doosaj and Bhagwat, 1933; Bhagwat and Doosaj, 1933.)

Results for aqueous solutions of:

Sodium Chloride at 25°

| Gms. per liter | |
|---|---|
| NaCl | $OHC_6H_4COOH$ |
| 0.0 | 2.478 |
| 1.176 | 2.229 |
| 5.88 | 2.219 |
| 11.76 | 2.150 |
| 14.70 | 2.125 |
| 19.6 | 2.075 |
| 29.40 | 2.000 |
| 39.20 | 1.901 |
| 58.80 | 1.719 |

Sodium Benzoate at 14.5°

| Gms. per liter | | Gms. per liter | |
|---|---|---|---|
| $C_6H_5COONa$ | $OHC_6H_4COOH$ | $C_6H_5COONa$ | $OHC_6H_4COOH$ |
| 0.0 | 1.667 | 34.612 | 4.189 |
| 1.7306 | 2.427 | 57.687 | 4.436 |
| 3.4612 | 3.393 | 86.530 | 4.285 |
| 6.9224 | 3.829 | 115.374 | 4.513 |
| 17.3061 | 4.171 | 173.061 | 5.460 |

Sodium Formate

| Gms. per liter | |
|---|---|
| HCOONa | $OHC_6H_4COOH$ |
| 4.656 | 8.624 |
| 6.858 | 10.35 |
| 9.000 | 12.08 |
| 13.092 | 15.15 |
| 24.002 | 21.04 |
| 33.234 | 26.36 |
| 36.003 | 27.07 |
| 48.005 | 32.02 |
| 72.007 | 39.87 |
| 144.014 | 63.66 |

Sodium Acetate

| Gms. per liter | |
|---|---|
| $CH_3COONa$ | $OHC_6H_4COOH$ |
| 2.355 | 4.828 |
| 3.533 | 6.026 |
| 7.064 | 9.122 |
| 10.428 | 11.73 |
| 19.909 | 19.32 |
| 36.489 | 31.06 |
| 43.799 | 36.22 |
| 72.998 | 57.25 |
| 109.497 | 77.43 |
| 218.993 | 147.20 |

Sodium Citrate

| Gms. per liter | |
|---|---|
| $C_3H_4OH(COONa)_3$ | $OHC_6H_4COOH$ |
| 0.0 | 2.743 |
| 5.370 | 7.875 |
| 7.924 | 10.26 |
| 15.131 | 15.92 |
| 27.745 | 24.91 |
| 33.295 | 29.73 |
| 55.492 | 43.17 |
| 83.238 | 57.15 |
| 110.984 | 71.91 |
| 166.475 | 90.78 |

## Solubility of Salicylic Acid in Aqueous Solutions of *o* Nitrobenzoic Acid at 25° and Vice Versa.

(Kendall, 1911.)

| Gms. per Liter. | | Solid Phase. | Gms. per Liter. | | Solid Phase. |
|---|---|---|---|---|---|
| *o* $C_6H_4NO_2$-COOH. | *o* $C_6H_4$-OHCOOH. | | *o* $C_6H_4.NO_2$.-COOH. | *o* $C_6H_4.OH$.-COOH. | |
| 0 | 2.257 | Salicylic Acid | 7.188 | 2.243 | *o* Nitrobenzoic Acid |
| 2.615 | 1.974 | " | 7.213 | 1.873 | |
| 7.202 | 1.887 | " | 7.233 | 1.294 | |
| 7.283 | 1.885 | " +Nitrobenzoic | | | |

## Solubility of Salicylic Acid in Aqueous Solutions of Sodium Salicylate at 20.1°.

(Hoitsema, 1898a.)

| Gm. Mols. per Liter. | | Sp. Gr. of Solutions. | Gms. per Liter. | | Solid Phase. |
|---|---|---|---|---|---|
| $C_6H_4OH$-COOH. | $C_6H_4OH$-COONa. | | $C_6H_4OH$-COOH. | $C_6H_4OH$-COONa. | |
| 0.0132 | 0 | 1.002 | 1.823 | 0 | $C_6H_4OHCOOH$ |
| 0.0112 | 0.017 | 1.003 | 1.55 | 2.705 | " |
| 0.0124 | 0.113 | 1.009 | 1.71 | 17.98 | " |
| 0.0143 | 0.226 | 1.016 | 1.97 | 35.96 | " |
| 0.0164 | 0.344 | 1.024 | 2.26 | 54.74 | " |
| 0.0203 | 0.500 | 1.034 | 2.80 | 79.56 | " |
| 0.062 | 1.70 | 1.112 | 8.56 | 270.5 | " |
| 0.095 | 2.11 | 1.137 | 13.11 | 335.7 | $C_6H_4OHCOOH.C_6H_4OHCOONa$ +$C_6H_4OHCOOH$ |
| 0.091 | 2.19 | 1.144 | 12.56 | 348.4 | $C_6H_4OHCOOH.C_6H_4OHCOONa$ |
| 0.086 | 3.41 | 1.215 | 11.88 | 542.6 | " |
| 0.081 | 4.23 | 1.263 | 11.19 | 673 | $C_6H_4OHCOOH.C_6H_4OHCOONa$ +$C_6H_4OHCOONa$ |
| 0.048 | 4.18 | 1.259 | 6.63 | 665.1 | $C_6H_4OHCOONa$ |
| 0.021 | 4.12 | 1.258 | 2.90 | 665.5 | " |
| 0. | 4.15 | 1.257 | 0 | 660.3 | " |

## Solubility of Salicylic Acid in Aqueous Alcohol at 25°.

(Seidell, 1908, 1909, 1910.)

| Wt. Per cent $C_2H_5OH$ in Solvent. | $d_{25}$ Sat. Sol. | Gms. $C_6H_4OHCOOH$ per 100 Gms. Sat. Sol. | Wt. Per cent $C_2H_5OH$ in Solvent. | $d_{25}$ of Sat. Sol. | Gms. $C_6H_4OHCOOH$ per 100 Gms. Sat. Sol. |
|---|---|---|---|---|---|
| 10 | 0.984 | 0.38 | 60 | 0.943 | 18.30 |
| 20 | 0.970 | 0.80 | 70 | 0.941 | 24 |
| 30 | 0.959 | 2.20 | 80 | 0.937 | 28.30 |
| 40 | 0.951 | 5.90 | 90 | 0.930 | 31.40 |
| 50 | 0.945 | 12.20 | 100 | 0.919 | 33.20 |

## Solubility of Salicylic Acid in Aqueous Ethyl Alcohol.

(Wright, 1927.) (Halford, 1933.)

| $t^0$ | Wt. % $C_2H_5OH$ in solvent | Gms. $OHC_6H_4COOH$ per 100 gms. solvent | $t^0$ | Wt. % $C_2H_5OH$ in solvent | Gms. $OHC_6H_4COOH$ per 100 gms. solvent |
|---|---|---|---|---|---|
| | | | 25 | 0.0 | 0.2112 |
| 20 | 0.0 | 0.22 | " | 19.8 | 0.537 |
| " | 50.0 | 11.8 | " | 37.57 | 4.57 |
| " | 100.0 | 51.5 | " | 56.2 | 14.72 |
| 30 | 0.0 | 0.31 | " | 75.0 | 24.90 |
| | 50.0 | 17.95 | " | 93.8 | 30.27 |
| | 100.0 | 57.25 | | | |

## Solubility of Salicylic Acid in Aqueous Solutions of Ethyl Alcohol, Isobutyl Alcohol, Dextrose, Cane Sugar, and of Levulose at 25° and at 35°.

(Hoffmann and Langbeck, 1905.)

| Aq. Solvent. | Conc. of Solvent. | | $C_6H_4OH.COOH$ Dissolved at 25°. | | $C_6H_4OH.COOH$ Dissolved at 35°. | |
|---|---|---|---|---|---|---|
| | Normality. | Gms. per Liter. | Gm. Mol. Per cent. | Gms. per 100 Gms. Sat. Sol. | Gm. Mol. Per cent. | Gms. per 100 Gms Sat. Sol. |
| $C_2H_5OH$ | 0.0249 | 1.146 | $2.8966.10^{-4}$ | 0.222 | $4.2044.10^{-4}$ | 0.322 |
| " | 0.0560 | 2.578 | 2.9150 " | 0.223 | 4.2348 " | 0.324 |
| " | 0.1747 | 8.04 | 2.9901 " | 0.229 | ... | ... |
| " | 0.2399 | 11.05 | ... | ... | 4.4341 " | 0.339 |
| " | 1.03 | 47.4 | 3.5279 " | 0.270 | 5.2816 " | 0.404 |
| " | 1.638 | 75.44 | 3.9253 " | 0.300 | ... | ... |
| $C_4H_9OH$ (iso) | 0.020 | 1.496 | 2.909 " | 0.223 | 4.229 " | 0.324 |
| " | 0.051 | 3.74 | 2.955 " | 0.226 | 4.289 " | 0.329 |
| " | 0.100 | 7.48 | 3.033 " | 0.232 | 4.435 " | 0.339 |
| " | 0.521 | 38.60 | 3.718 " | 0.285 | 5.624 " | 0.431 |
| $C_6H_{12}O_6$ | 0.02 | 3.6 | 2.886 " | 0.221 | 4.184 " | 0.321 |
| " | 0.10 | 18 | 2.898 " | 0.222 | 4.202 " | 0.322 |
| " | 0.50 | 89.6 | 2.954 " | 0.226 | 4.263 " | 0.326 |
| " | 1 | 180 | 3.015 " | 0.231 | 4.360 " | 0.334 |
| $C_{12}H_{22}O_{11}$ | 0.02 | 6.88 | 2.902 " | 0.221 | 4.206 " | 0.322 |
| " | 0.10 | 34.97 | 2.964 " | 0.227 | 4.287 " | 0.328 |
| " | 0.50 | 172 | 3.239 " | 0.248 | 4.697 " | 0.360 |
| " | 1.10 | 376.3 | 3.633 " | 0.278 | 5.236 " | 0.401 |
| $C_6H_{12}O_6$ | 0.02 | 3.6 | 2.888 " | 0.221 | ... | ... |
| " | 0.06 | 10.8 | 2.895 " | 0.221 | ... | ... |
| " | 0.25 | 45 | 2.944 " | 0.225 | ... | ... |

## Solubility of Salicylic Acid in Aqueous Solutions of Saccharose at 18°.

(Kolthoff, 1927.)

| Gm. Mols. per liter | |
|---|---|
| $C_{12}H_{22}O_{11}$ | $o\text{-}OHC_6H_4COOH$ |
| 0.0 | 0.0125 |
| 0.5 | 0.0131 |
| 1.0 | 0.0134 |

## Solubility of Salicylic Acid in Aqueous Solutions of Dioxane at 25°.

(Herz and Lorentz, 1929.)

| Vol. % Dioxane in Aq. Solvent | Gm. Equiv. $o\text{-}OHC_6H_4COOH$ per liter |
|---|---|
| 10 | 0.03 |
| 30 | 0.22 |
| 70 | 2.73 |
| 80 | 3.06 |
| 100 | 3.05 |

Between 35 and 62% dioxane two layers are formed. The lower contains 2.29 gm. equiv. dioxane per liter and the upper 0.57 gm. equivalents.

Data showing the effect of increasing amounts of several gum arabic sols. upon the solubility of salicylic acid in water are given by Brintzinger and Beier, 1934.

DISTRIBUTION OF SALICYLIC ACID AT 25° BETWEEN: (Smith, 1921, 1922.)

Water and Chloroform.

| Millimols. $C_6H_4OHCOOH$ per liter of $H_2O$ layer ($C_1$). | Millimols. $C_6H_4OHCOOH$ per liter of $CHCl_3$ layer ($C_2$). | $\frac{C_2}{C_1}$. |
|---|---|---|
| 0.575 | 0.625 | 1.09 |
| 0.850 | 1.180 | 1.39 |
| 1.138 | 1.862 | 1.64 |
| 1.425 | 2.625 | 1.84 |
| 2.625 | 6.575 | 2.50 |

Water and Ethyl Ether.

| Millimols. $C_6H_4OHCOOH$ per liter of $H_2O$ layer ($C_1$). | Millimols. $C_6H_4OHCOOH$ per liter of $(C_2H_5)_2O$ layer ($C_2$). | $\frac{C_2}{C_1}$. |
|---|---|---|
| 0.0666 | 1.3975 | 21.0 |
| 0.0850 | 2.415 | 28.4 |
| 0.125 | 3.855 | 30.8 |
| 0.195 | 7.645 | 39.2 |
| 0.295 | 14.825 | 50.3 |

Water and Xylene.

| Millimols. $C_6H_4OHCOOH$ per liter of $H_2O$ layer ($C_1$). | Millimols. $C_6H_4OHCOOH$ per liter of Xylene layer ($C_2$). | $\frac{C_2}{C_1}$. |
|---|---|---|
| 1.038 | 0.550 | 0.530 |
| 1.350 | 0.862 | 0.638 |
| 1.785 | 1.238 | 0.692 |
| 3.075 | 3.075 | 1.000 |
| 4.675 | 5.675 | 1.215 |

DISTRIBUTION OF SALICYLIC ACID BETWEEN WATER AND PHENOL AT 25°.
(Bailey, 1925.)

| Gms. $C_6H_4OHCOOH$ per liter of | | | | | | |
|---|---|---|---|---|---|---|
| | Aqueous layer..... | 0.38 | 1.27 | 2.07; | 4.57 | 5.28 |
| | Phenol layer..... | 5.36 | 19.07 | 32.93 | 77.72 | 93.34 |

The concentration in the aqueous layer was corrected for ionization.

DISTRIBUTION OF SALICYLIC ACID BETWEEN:

Water and Benzene. (Hendrixon, 1897.)

| Results at 10°. Gms. Acid 100 cc. $H_2O$ Layer. | Results at 10°. Gms. Acid 100 cc. $C_6H_6$ Layer. | Results at 40°. Gms. Acid per 100 cc. $H_2O$ Layer | Results at 40°. Gms. Acid per 100 cc. $C_6H_6$ Layer. |
|---|---|---|---|
| 0.0264 | 0.0391 | 0.0260 | 0.0400 |
| 0.0377 | 0.0655 | 0.0719 | 0.1649 |
| 0.1200 | 0.4159 | 0.1220 | 0.3539 |
| 0.1292 | 0.4713 | 0.1563 | 0.5016 |
| | | 0.2014 | 0.7625 |

Water and Chloroform. (Hendrixon, 1897.)

| Results at 10°. Gms. Acid per 100 cc. $H_2O$ Layer. | Results at 10°. Gms. Acid per 100 cc. $CHCl_3$ Layer. | Results at 40°. Gms. Acid per 100 cc. $H_2O$ Layer. | Results at 40°. Gms. Acid per 100 cc. $CHCl_3$ Layer. |
|---|---|---|---|
| 0.0293 | 0.0442 | 0.0335 | 0.0475 |
| 0.0457 | 0.0946 | 0.0819 | 0.1775 |
| 0.1172 | 0.5640 | 0.1589 | 0.5297 |
| 0.1229 | 0.6196 | 0.2687 | 1.3887 |
| 0.1236 | 0.6269 | 0.3053 | 1.7570 |

Similar data for the distribution between water and benzene at 18° are given by Nernst (1891).

DISTRIBUTION OF SALICYLIC ACID BETWEEN WATER AND BENZENE AT 25°.
(Szyzkowski, 1928; Szyzkowski and Skapski, 1928.)

| Gm. Mols. of $OHC_6H_4COOH$ per liter $H_2O$ layer | Gm. Mols. of $OHC_6H_4COOH$ per liter $C_6H_6$ layer |
|---|---|
| 0.002603 | 0.004401 |
| 0.002938 | 0.005245 |
| 0.003732 | 0.006345 |
| 0.004451 | 0.009543 |
| 0.005032 | 0.01149 |

| Gm. Mols. of $OHC_6H_4COOH$ per liter $H_2O$ layer | Gm. Mols. of $OHC_6H_4COOH$ per liter $C_6H_6$ layer |
|---|---|
| 0.00930 | 0.02904 |
| 0.01021 | 0.03396 |
| 0.01187 | 0.04079 |
| 0.01240 | 0.04617 |
| 0.01460 | 0.06150 |
| 0.01610 | 0.07250 |

Szyzkowski and Skapski also give results for the distribution of Salicylic acid between benzene and aqueous solutions of $NaCl$, $NaClO_3$, $NaNO_3$, $BaCl_2$, $Na_2SO_4$, and $MgSO_4$ at 25°.

DISTRIBUTION OF SALICYLIC ACID AT 25° BETWEEN:
(Smith and White, 1929.)

Water and Chloroform

| Gm. Mol. of $OHC_6H_4COOH$ per liter $H_2O$ layer | Gm. Mol. of $OHC_6H_4COOH$ per liter $CHCl_3$ layer |
|---|---|
| 0.00370 | 0.01055 |
| 0.00410 | 0.0123 |
| 0.00449 | 0.0146 |
| 0.00489 | 0.0169 |
| 0.00528 | 0.0196 |
| 0.00568 | 0.0224 |

Water and Toluene

| Gm. Mol. of $OHC_6H_4COOH$ per liter $H_2O$ layer | Gm. Mol. of $OHC_6H_4COOH$ per liter $C_6H_5CH_3$ layer |
|---|---|
| 0.00550 | 0.00924 |
| 0.00660 | 0.0119 |
| 0.00770 | 0.0154 |
| 0.00924 | 0.0199 |
| 0.0109 | 0.0251 |
| 0.0121 | 0.0308 |

## SALICYLIC ACID

### Distribution of Salicylic Acid at 25° Between Benzene and Aqueous Solutions of Potassium Chloride. (De Szyszkowski, 1914.)

| Normality of Aq. K Cl. | Gm. mols. $C_6H_4OH\,COOH$ per 1000 gms. $C_6H_6$ layer. | Aq. K Cl layer. |
|---|---|---|
| 0.1... | $3.999.10^{-3}$ | $3.596.10^{-3}$ |
| 0.1... | 6.46 » | 3.794 » |
| 0.1... | 10.68 » | 5.252 » |
| 0.1... | 23.00 » | 8.489 » |
| 0.1... | 44.20 » | 12.29 » |
| 0.1... | 62.70 » | 15.20 » |
| 0.1... | 72.44 » | 16.34 » |
| 0.25.. | 4.871 » | 3.004 » |
| 0.25.. | 7.12 » | 3.896 » |
| 0.25.. | 11.62 » | 5.343 » |
| 0.25.. | 25.09 » | 8.57 » |
| 0.25.. | 41.78 » | 11.63 » |
| 0.25.. | 62.80 » | 14.76 » |
| 0.5... | $4.728.10^{-3}$ | $2.744.10^{-3}$ |
| 0.5 .. | 7.466 » | 3.837 » |
| 0.5... | 11.77 » | 5.171 » |
| 0.5... | 27.96 » | 8.702 » |
| 0.5... | 41.16 » | 10.76 » |
| 0.5... | 56.01 » | 12.93 » |
| 0.75.. | 3.995 » | 2.529 » |
| 0.75.. | 6.572 » | 3.504 » |
| 0.75.. | 10.03 » | 4.430 » |
| 0.75.. | 21.09 » | 7.021 » |
| 0.75.. | 38.32 » | 9.995 » |
| 0.75.. | 56.59 » | 12.45 » |
| 1.0... | 4.095 » | 2.461 » |
| 1.0... | 29.30 » | 7.818 » |
| 1.0... | 72.02 » | 13.12 » |

| | | Gm. mols. $C_6H_4OH\,COOH$ at 25°. |
|---|---|---|
| 1000 gms. Benzene in contact with aq. 0.1 *n* KCl | contain... | $7.274.10^{-2}$ |
| » » » 1.0 *n* KCl | » ... | 7.202 » |
| » » » a large excess of $H_2O$ | » ... | 7.370 » |
| » » previously sat. with $H_2O$ | « ... | 6.321 » |
| « dry Benzene contain..... | | 5.616 » |

The mixtures were shaken in a thermostat for 3 to 7 days. (De Szyszkowski, 1914.

### Solubility of Salicylic Acid in Benzene at 30°.5 as Influenced by Small Amounts of Water.

(Cohen and van Dobbenburgh, 1925; Cohen and Miyake, 1926.)

A special apparatus was devised and determinations of the highest accuracy were made.

| Wt. % $H_2O$ contained in $C_6H_6$ used. | Gms. $C_6H_4OH\,COOH$ per 100 gms. sat. sol. | Wt. % $H_2O$ contained in $C_6H_6$ used. | Gms. $C_6H_4OH\,COOH$ per 100 gms. sat. sol. |
|---|---|---|---|
| None (= dry $C_6H_6$). | 1.001 to 1.021 | 0.1042..... | 1.309 |
| 0.0940..... | 1.015 | 0.1478..... | 1.348 |
| 0.0147..... | 1.050 | 0.2171..... | 1.351 |
| 0.0374..... | 1.095 | 0.3130..... | 1.352 |
| 0.0682..... | 1.190 | Excess $H_2O$... | 1.356 |

### Solubility of Salicylic Acid in Carbon Tetrachloride and in Chloroform at 30°.5 as Influenced by Very Small Amounts of Water.

(Cohen and Miyake, 1926.)

Equilibrium was approached from above and below, by constant agitation of the mixtures in sealed flasks.

Carbon Tetrachloride.

| Wt. % $H_2O$ in $CCl_4$ used. | Gms. $C_6H_4OH\,COOH$ per 100 gms. sat. sol. |
|---|---|
| None (= dry $CCl_4$). | 0.35–0.36 |
| 0.0087..... | 0.35–0.37 |
| 0.0227..... | 0.36 |
| 0.0659..... | 0.36–0.37 |
| Excess $H_2O$..... | 0.36 |

Chloroform.

| Wt. % $H_2O$ in $CHCl_3$ used. | Gms. $C_6H_4OH\,COOH$ per 100 gms. sat. sol. |
|---|---|
| None (= dry $CHCl_3$) | 1.55–1.56 |
| 0.0354..... | 1.63–1.64 |
| 0.0608..... | 1.68–1.69 |
| 0.1081..... | 1.71–1.82 |
| Excess $H_2O$..... | 1.72–1.73 |

1000 gms. Carbon tetrachloride sat. with $H_2O$ contain 0.01902 gm. mols. $C_6H_4OH\,COOH$ at 25°.

1000 gms, Chloroform sat. with $H_2O$ contain 0.1338 gm. mols. $C_6H_4OH\,COOH$ at 25°.

(De Szyszkowski, 1914.)

### Solubility of Salicylic Acid in Alcohols, in Ether and in Acetone.

(Timofeiew, 1891; at 15°, Bourgoin, 1878; at 23°, Walker and Wood, 1898.)

| Solvent. | t°. | Gms. $C_6H_4OHCOOH$ per 100 Gms. Solvent. | Gms. $C_6H_4OHCOOH$ per 100 Gms. Solution. | Solvent. | t°. | Gms. $C_6H_4OHCOOH$ per 100 Gms. Solvent. | Gms. $C_6H_4OHCOOH$ per 100 Gms. Solution. |
|---|---|---|---|---|---|---|---|
| $CH_3OH$ | − 3 | 40.67 | 28.91 | $C_3H_7OH(n)$ | − 3 | 26.12 | 20.71 |
| $CH_3OH$ | +21 | 62.48 | 38.46 | $C_3H_7OH(n)$ | +21 | 37.69 | 27.36 |
| $C_2H_5OH$ | − 3 | 36.12 | 26.29 | $(CH_3)_2O$ | 15 | 50.47 | 33.55 |
| $C_2H_5OH$ | +15 | 49.63 | 33.17 | $(CH_3)_2O$ | 17 | ... | 23.4* |
| $C_2H_5OH$ | 21 | 53.53 | 34.87 | $(CH_3)_2CO$ | 23 | ... | 31.3* |
| $C_2H_5OH$ 90% | 15 | 42.09 | 29.62 | | | | |

* Gms. per 100 cc. sat. sol. instead of per 100 gms. sat. sol.

100 gms. sat. solution in methyl alcohol contain 39.87 gms. salicylic acid at 15°. (Savorro, 1914.)

### Solubility of Salicylic Acid in Mixtures of Acetone and Benzene at 25°.

(Marden and Dover, 1917.)

| Gms. per 100 Gms. Mixed Solvent. | | Gms. per 100 Gms. Mixed Solvent. | | Gms. per 100 Gms. Mixed Solvent. | |
|---|---|---|---|---|---|
| Acetone. | Salicylic Acid. | Acetone. | Salicylic Acid. | Acetone. | Salicylic Acid. |
| 100 | 55 | 60 | 36.7 | 20 | 15 |
| 90 | 51.1 | 50 | 31 | 10 | 7.1 |
| 80 | 46.4 | 40 | 25.3 | 0 | 0.92 |
| 70 | 42.3 | 30 | 20 | | |

Results for the solubility of Salicylic acid in benzene are given by Miyake, 1930.

### Solubility of Salicylic Acid in Benzene.

(Walker and Wood, 1898.)

| t°. | Gms. $C_6H_4OHCOOH$ per 100 Gms. $C_6H_6$. | t°. | Gms. $C_6H_4OHCOOH$ per 100 Gms. $C_6H_6$. |
|---|---|---|---|
| 11.7 | 0.460 | 34.6 | 1.261 |
| 18.2 | 0.579 | 36.6 | 1.430 |
| 25 | 0.78 | 49.4 | 2.380 |
| 30.5 | 0.991 | 64.2 | 4.40 |

(von Euler and Löwenhamn, 1916.)

| t°. | Solvent. | Gms. $C_6H_4OHCOOH$ per 100 cc. Sat. Sol. |
|---|---|---|
| 18 | $C_6H_6$ | 0.525 |
| 25 | $C_6H_6$ | 0.762 |
| 18 | 0.5*n* $CH_2ClCOOH$ in $C_6H_6$ | 1.698 |
| 18 | 0.5*n* $C_6H_5OH$ in $C_6H_6$ | 0.746 |

### Solubility of Salicylic Acid in Mixtures of Benzene and Ethyl Acetate at 25°.

(Marden and Dover, 1917.)

| Gms. per 100 Gms. Mixed Solvent. | | Gms. per 100 Gms. Mixed Solvent. | | Gms. per 100 Gms. Mixed Solvent. | |
|---|---|---|---|---|---|
| Ethyl Acetate. | Salicylic Acid. | Ethyl Acetate. | Salicylic Acid. | Ethyl Acetate. | Salicylic Acid. |
| 100 | 38 | 60 | 16.6 | 20 | 6.2 |
| 90 | 24.2 | 50 | 14.5 | 10 | 3.42 |
| 80 | 22.7 | 40 | 12.8 | 0 | 0.92 |
| 70 | 19.5 | 30 | 9.6 | | |

### Solubility of Salicylic Acid in Several Solvents at 25°.

(Herz and Rathmann, 1913.)

| Solvent. | Gms. $C_6H_4OHCOOH$ per 100 cc. Sat. Sol. | Solvent. | Gms. $C_6H_4OHCOOH$ per 100 cc. Sat. Sol. |
|---|---|---|---|
| Chloroform | 2.168 | Tetrachlor Ethylene | 1.105 |
| Carbon Tetrachloride | 0.4143 | Tetrachlor Ethane | 2.085 |
| Trichlor Ethylene | 1.519 | Pentachlor Ethane | 1.064 |

100 gms. dichlor ethylene dissolve 0.757 gm. salicylic acid at 15°. } (Wester and
100 gms. trichlor ethylene dissolve 0.28 gm. salicylic acid at 15°. } Bruins, 1914.)

100 gms. 86.5% Glycerol ($d = 1.2326$) dissolve 0.97 gm. $C_6H_4OHCOOH$ at 20°.
" 98.5 " ($d = 1.2645$) " 1.62 "
(Holm, 1921; 1921*a*, 1922.

100 gms. Cymene (b. pt. 176°-176°.5) dissolve 0.975 gm. $C_6H_4OHCOOH$ at 25°.
(Wheeler, 1920.)

### Solubility of Salicylic Acid in Several Solvents.

(Sidgwick and Ewbank, 1921a.)

Results for:

| Ethyl alcohol (99.0%) | | n Butyl Alcohol | | Benzene | | n Heptane | |
|---|---|---|---|---|---|---|---|
| t° | Gms. o $OHC_6H_4COOH$ per 100 gms. sat. sol. | t° | Gms. o $OHC_6H_4COOH$ per 100 gms. sat. sol. | t° | Gms. o $OHC_6H_4COOH$ per 100 gms. sat. sol. | t° | Gms. o $OHC_6H_4COOH$ per 100 gms. sat. sol. |
| 41.0 | 40.6 | 24.0 | 24.36 | 44.3 | 1.92 | 92.2 | 2.09 |
| 85.2 | 60.4 | 38.0 | 28.88 | 65.0 | 5.27 | 112.4 | 5.37 |
| 125.2 | 81.2 | 85.6 | 48.9 | 98.5 | 20.8 | 134.3 | 20.15 |
| | | 121.6 | 79.2 | 114.5 | 41.1 | 142.0 | 41.6 |
| | | | | 131.5 | 64.5 | 149.5 | 81.4 |
| | | | | 140.0 | 81.3 | | |

### Solubility of Salicylic Acid in Several Solvents at 28°.

(Desai and Patel, 1935.)

| Solvent | Gm. Mol. o $OHC_6H_4COOH$ per 1.0 gm. mol. sat. sol. | Solvent | Gm. Mol. o $OHC_6H_4COOH$ per 1.0 gm. mol. sat. sol. |
|---|---|---|---|
| Water | 0.0003118 | Nitro benzene | 0.02509 |
| Hexane | 0.00111 | Chloroform | 0.02679 |
| $CCl_4$ | 0.003803 | Methyl alcohol | 0.1252 |
| Benzene | 0.005441 | Ethyl alcohol | 0.1479 |
| Toluene | 0.006052 | n Propyl alcohol | 0.1438 |
| m Xylene | 0.006554 | n Butyl alcohol | 0.1568 |
| Chloro benzene | 0.007903 | Acetone | 0.1906 |

Results in the form of diagrams are given by Desai and Patel, 1935a for the solubility of salicylic acid in binary mixtures of the above solvents.

### Solubility of Salicylic Acid in Several Oils at 23°.

(Verkade, 1921.)

Very carefully refined fatty oils were used.

| Oil. | Gms. $C_6H_4OHCOOH$ per 100 gms. oil. | Oil. | Gms. $C_6H_4OHCOOH$ per 100 gms. oil. |
|---|---|---|---|
| Olive oil..... | 2.43 (2.59) | Cocoanut oil..... | 3.18 |
| Cotton seed oil..... | 2.55 | Linseed oil..... | 3.42 |
| Peanut oil I..... | 2.82 | Castor oil..... | 14.81 |
| » II..... | 2.39 | | |

The result in parentheses is by Watermann

### Solubility of Salicylic Acid in Oils (Temp. not stated).

(Engfeldt, 1913.)

| Oil of: | Gms. $C_6H_4OHCOOH$ per 100 Gms. Sat. Sol. | Oil of: | Gms. $C_6H_4OHCOOH$ per 100 Gms. Sat. Sol. |
|---|---|---|---|
| Phocae (Dog Fish Oil) | 1.70 | Sesami | 2.61 |
| Jecoris Aselli (Cod Liver Oil) | 1.86 | Cannabis | 3 |
| Arachidis (Peanut Oil) | 1.88 | Lini (Linseed Oil) | 3.04 |
| Amygdalarum | 2.08 | Juglandis (Walnut Oil) | 3.15 |
| Olivæ (Olive Oil) | 2.14 | Gossypii (Cottonseed Oil) | 3.23 |
| Rapæ (Rape Seed Oil) | 2.17 | Ricini (Castor Oil) | 12.98 |
| Papaveris (Poppy Seed Oil) | 2.22 | Paraffiniam Liquid | 0 |

The ratio of the solubilities of salicylic acid in olive oil and in water (conc. in oil ÷ conc. in $H_2O$) at 25° is given as 11.8 by Boeseken and Waterman (1911, 1912). This corresponds to 2.6 gms. acid per 100 gms. olive oil.

### Solubility of Salicylic Acid in Mixtures of Benzene and Heptane at 25°.

(Herz and Levi, 1930.)

| Vol. % $C_6H_6$ in $C_6H_6$ + $C_7H_{16}$ Mixture | Gm. Mols. $OHC_6H_4COOH$ per liter sat. sol. | Vol. % $C_6H_6$ in $C_6H_6$ + $C_7H_{16}$ Mixture | Gm. Mols. $OHC_6H_4COOH$ per liter sat. sol. |
|---|---|---|---|
| 100 | 0.050 | 40 | 0.0422 |
| 80 | 0.0473 | 20 | 0.0371 |
| 60 | 0.0449 | 0 | 0.0279 |

Freezing-point data are given for mixtures of Salicylic Acid and:

Acetamide(12)(22)
Acetanilide + Antipyrine(9)
Acetanilide + Urea(9a)
Antipyrine + Benzoic Acid(6)
Antipyrine(13)
Azobenzene(16)
Benzoic Acid(23)
Benzoic Acid + Antipyrine(6)
Benzamide(12)
Caffeine(21)
Camphor(10)(17)(18)
Dimethyl pyrone(11)
Cineole(3)
Iodo benzoic acid(19)
Naphthalene(2)
Naphthol(1)(4)
Naphthylamines(15)(20)
Nitro toluene(5)
Oxy benzaldehyde(14)
Phenylene diamines(15)
Thymol(7)
Toluidine(15)(16)
Tri nitro toluene(5)
Urea(6)(16)(15)
Urea + Acetanilide(9a)
Urea + Urethan(8)

(1) Bartholomew and Wark, 1926; Bernouilli and Sarasin, 1930; (3) Bellucci and Grassi, 1913; (4) Castiglione, 1937; (5) Crockford and Zurburg, 1930; (6) Hrynakowski, 1934; (7) Hrynakowski and Szmyt, 1935; (8) Hrynakowsky and Szmyt, 1935a; (9) Hrynakowski and Szmyt, 1935b; (9a) Hrynakowski and Szmyt, 1935c; (10) Jefremow, 1913; (11) Kendall, 1914a; (12) Kremann and Auer, 1918; (13) Kremann and Haas, 1919; (14) Kremann and Pogantsch, 1923; (15) Kremann, Weber and Zechner, 1925; (16) Kremann and Zechner, 1925; (17) Lajoux, 1917; (18) LeFevre and Tideman, 1931; (19) Lettre and Lehmann, 1938; (20) Milone and Rossignoli, 1932; (21) Regenbogen and Schoorl, 1924; (22) Rheinboldt, Henning and Kirscheisen, 1925; (23) Jaeger, 1907.

## HYDROXY BENZOIC ACID m $OHC_6H_4COOH$.

### Solubility of Meta Hydroxy Benzoic Acid in Water.

Average curve from the results of Walker and Wood, 1898; Savorro, 1914; Flaschner and Rankin, 1910; Sidgwick and Ewbank, 1921a.

| t° | Gms. m $OHC_6H_4COOH$ per 100 gms. sat. sol. | t° | Gms. m $OHC_6H_4COOH$ per 100 gms. sat. sol. | t° | Gms. m $OHC_6H_4COOH$ per 100 gms. sat. sol. |
|---|---|---|---|---|---|
| 0 | 0.35 | 50 | 3.0 | 110 | 50.0 |
| 10 | 0.55 | 60 | 4.3 | 120 | 60.0 |
| 20 | 0.85 | 70 | 7.0 | 140 | 76.0 |
| 25 | 1.07 | 80 | 11.0 | 160 | 86.0 |
| 30 | 1.35 | 90 | 20.0 | 180 | 93.0 |
| 40 | 2.0 | 100 | 37.0 | 201m.pt. | 100.0 |

### Solubility of Meta Hydroxy Benzoic Acid in Aqueous 0.01 Molar Sodium Salt(?) Solutions Containing Increasing Amounts of Potassium Chloride at 25°

(Osol and Kilpatrick, 1933a.)

| Gm. Mols. KCl per liter | d. of sat. sol. | Gm. Mol. m $OHC_6H_4COOH$ per liter | Gm. Mols. KCl per liter | d. of sat. sol. | Gm. Mol. m $OHC_6H_4COOH$ per liter |
|---|---|---|---|---|---|
| 0.0 | 1.0000 | 0.0706 (= 9.745 gms.) | 1.0 | 1.044 | 0.0529 |
| 0.2 | 1.010 | 0.0657 | 1.5 | 1.067 | 0.0470 |
| 0.5 | 1.024 | 0.0606 | 2.0 | 1.088 | 0.0399 |

The coefficient of distribution of meta hydroxy benzoic acid between water and olive oil is 0.4. (Boeseken and Waterman, 1911.)

### Solubility of Meta Hydroxy Benzoic Acid in Benzene.

(Walker and Wood, 1898.)

| t° | Gms. m $OHC_6H_4COOH$ per 100 gms. $C_6H_6$ | t° | Gms. m $OHC_6H_4COOH$ per 100 gms. $C_6H_6$ |
|---|---|---|---|
| 20 | 0.008 | 40 | 0.017 |
| 25 | 0.010 | 50 | 0.028 |
| 30 | 0.012 | 60 | 0.047 |

100 cc sat. solution of meta hydroxy benzoic acid in Acetone contain 26.0 gms. m $OHC_6H_4COOH$ at 23°.

100 cc sat. solution of meta hydroxy benzoic acid in Ethyl Ether contain 9.73 gms. m $OHC_6H_4COOH$ at 17°. (Walker and Wood, 1898.)

100 gms. sat. solution of m hydroxy benzoic acid in $CH_3OH$ contain 53.58 gms. m $OHC_6H_4COOH$ at 15°. (Savorro, 1914.)

100 gms. 95% formic acid dissolve 2.37 gms. m $OHC_6H_4COOH$ at 20.8°. (Aschan, 1913.)

### Solubility of Meta Hydroxy Benzoic Acid in Several Solvents.

(Sidgwick and Ewbank, 1921a.)

| Solvent | t° | Gm. m $OHC_6H_4COOH$ per 100 gms. sat. sol. | Solvent | t° | Gm. m $OHC_6H_4COOH$ per 100 gms. sat. sol. |
|---|---|---|---|---|---|
| Ethyl Alcohol (99%) | 65.0 | 39.6 | Benzene | 122.5 | 1.23 |
| " " | 132.0 | 61.3 | " | 141.0 | 2.95 |
| " " | 160.0 | 81.7 | " | 154.5 | 5.16 |
| n Butyl Alcohol | 36.5 | 20.7 | " | 162.0 | 10.54 |
| " " | 115.0 | 40.8 | " | 173.0 | 22.4 |
| " " | 151.2 | 59.2 | " | 182.5 | 41.6 |
| " " | 180.3 | 84.7 | " | 185.5 | 62.3 |
| n Heptane " | 176.0 | 0.86 (liquid) | " | 192.15 | 82.3 |
| " | 197.0 (tr.pt.) | 2.0 " | | | |

Freezing-point data are given for mixtures of meta hydroxy benzoic acid and:

Benzamide (Kremann and Auer, 1918.)
Cineole (Bellucci and Grassi, 1913.)
Iodo benzoic acid (Lettre and Lehmann, 1938.)
Michler's ketone (Pfeiffer, 1924.)
Tetra methyl diamino benzo phenone (Pfeiffer, Goebel and Angern, 1925.)

## HYDROXY BENZOIC ACID p $OHC_6H_4COOH$.

### Solubility of Para Hydroxy Benzoic Acid in Water.

(Up to 50°, Walker and Wood, 1898; Above 50°, average curve from the closely agreeing results of Flaschner and Rankin, 1910 and Sidgwick and Ewbank, 1921a.)

| t° | Gms. p $OHC_6H_4COOH$ per 100 gms. sat. sol. | t° | Gms. p $OHC_6H_4COOH$ per 100 gms. sat. sol. | t° | Gms. p $OHC_6H_4COOH$ per 100 gms. sat. sol. |
|---|---|---|---|---|---|
| 10 | 0.25 | 50 | 2.3 | 120 | 59.0 |
| 15 | — (0.44) | 60 | 4.2 | 130 | 67.0 |
| 20 | 0.50 | 70 | 7.0 | 140 | 73.0 |
| 25 | 0.64 | 80 | 12.0 | 160 | 82.5 |
| 30 | 0.81 | 90 | 20.0 | 180 | 90.5 |
| 35 | 1.00 | 100 | 33.3 | 200 | 97.0 |
| 40 | 1.23 | 110 | 47.8 | 213 m.pt. | 100.0 |
| 50 | 2.07 (2.98) | | | | |

The results in parentheses are by Savarro, 1914.

Para hydroxy benzoic acid crystallizes with 1 $H_2O$ and the triple point is at 62°. (Sidgwick and Ewbank, 1921a.)

One liter sat. solution of para hydroxy benzoic acid in water contain 0.0454 gm. mol. (= 6.267 gms.) p $OHC_6H_4COOH$ at 25°. (Osol and Kilpatrick, 1933a.)

### Distribution of Para Hydroxy Benzoic Acid Between Water and Ethyl Ether at 25° (Smith, 1921-1922.)

| Millimols. *p* OH.$C_6H_4$.COOH per liter of | | $\frac{C_2}{C_1}$. | Millimols. *p* OH.$C_6H_4$COOH per liter of | | $\frac{C_2}{C_1}$. |
|---|---|---|---|---|---|
| $H_2O$ layer ($C_1$). | $(C_2H_5)_2O$ layer ($C_2$). | | $H_2O$ layer ($C_1$). | $(C_2H_5)_2O$ layer ($C_2$). | |
| 0.3125 | 2.2625 | 7.23 | 0.875 | 7.425 | 8.50 |
| 0.400 | 3.250 | 8.13 | 1.40 | 12.8 | 9.15 |
| 0.575 | 5.025 | 8.72 | | | |

Freezing-point lowering data for mixtures of *m* hydroxy benzoic acid and Michler's ketone are given by Pfeiffer, 1924.

The coefficient of distribution of para hydroxy benzoic acid between water and olive oil is 0.6. (Boeseken and Waterman, 1911.)

### Solubility of Para Hydroxy Benzoic Acid in Benzene.

(Walker and Wood, 1898.)

| t° | Gms. p $OHC_6H_4COOH$ per 100 gms. $C_6H_6$ | t° | Gms. p $OHC_6H_4COOH$ per 100 gms. $C_6H_6$ |
|---|---|---|---|
| 10 | 0.0018 | 40 | 0.0082 |
| 20 | 0.0027 | 50 | 0.0162 |
| 25 | 0.0035 | 60 | 0.028 |
| 30 | 0.0045 | 80 | 0.066 |

100 cc sat. sol. of p hydroxy benzoic acid in Acetone contain 22.6 gms. at 23°.

100 cc sat. sol. of p hydroxy benzoic acid in ethyl ether contain 9.43 gms. at 17°. (Walker and Wood, 1898.)

100 gms. sat. sol. of p hydroxy benzoic acid in Methyl Alcohol contain 236.22 gms. at 15°. (Savorro, 1914.)

## HYDROXY BENZOIC ACIDS

### Solubility of Para Hydroxy Benzoic Acid in Several Solvents.

(Sidgwick and Ewbank, 1921a.)

| Solvent | t° | Gms. p $OHC_6H_4COOH$ per 100 gms. sat. sol. | Solvent | t° | Gms. p $OHC_6H_4COOH$ per 100 gms. sat. sol. |
|---|---|---|---|---|---|
| Ethyl Alcohol (99%) | 67 | 38.75 | Benzene | 132.2 | 1.04 |
| " " | 136.5 | 60.9 | " | 156.9 | 3.04 |
| " " | 184.0 | 82.9 | " | 165.2 | 4.3 |
| n Butyl " | 32.5 | 19.5 | " | 178.0 | 10.3 |
| " " | 62.0 | 25.08 | " | 191.5 | 21.0 |
| " " | 116.1 | 39.45 | " | 195.7 | 40.6 |
| " " | 167.0 | 62.4 | " | 198.8 | 61.3 |
| " " | 193.8 | 85.5 | " | 206.0 | 83.0 |
| " | | | n Heptane | 197.0 | 1.6 (liquid) |
| | | | | 208.5 (tr.pt.) | 1.8 |

Freezing-point data are given for mixtures of para hydroxy benzoic acid and:

Benzamide (Kremann & Auer, 1918.)
Cineole (Bellucci and Grassi, 1913.)
Iodo benzoic acid (Lettre and Lehmann, 1938.)
Sarcosine anhydride (Pfeiffer, Angern, Wang, Seydel and Quehl, 1930.)

## RESORCYLIC ACID (Resorcinilic Acid).

### Distribution of Resorcinilic Acid at 25° Between :

(Smith, 1921, 1922.)

Water and Ether.

| Millimols. per liter of | | |
|---|---|---|
| $H_2O$ layer ($C_1$). | $(C_2H_5)_2O$ layer ($C_2$). | $\frac{C_2}{C_1}$. |
| 0.1350 | 1.5950 | 11.81 |
| 0.2812 | 4.5187 | 16.00 |
| 0.3875 | 8.7125 | 22.50 |
| 0.50 | 12.75 | 25.50 |

Water and Xylene.

| Millimols. per liter of | | |
|---|---|---|
| $H_2O$ layer ($C_1$). | Xylene layer ($C_2$). | $\frac{C_2}{C_1}$. |
| 19.2 | 0.50 | 0.0260 |
| 26.8 | 0.80 | 0.0298 |
| 40.5 | 1.50 | 0.037 |

Note. — The author describes the compound here studied as resorcinilic acid and gives no information which would permit its more accurate identification.

## GENTISIC ACID (2.5 dihydroxy benzoic acid) 2.5 $(OH)_2C_6H_3COOH$.

### Distribution of Gentisic Acid at 25° Between :

(Smith, 1921-1922.)

Water and Chloroform.

| Millimols. per liter | | |
|---|---|---|
| $H_2O$ layer ($C_1$) | $CHCl_3$ layer ($C_2$). | $\frac{C_2}{C_1}$. |
| 15.20 | 0.32 | 0.0210 |
| 20.70 | 0.45 | 0.0217 |
| 38.40 | 0.90 | 0.0234 |

Water and Ether.

| Millimols. per liter | | |
|---|---|---|
| $H_2O$ layer ($C_1$). | $(C_2H_5)_2O$ layer ($C_2$) | $\frac{C_2}{C_1}$. |
| 0.31 | 1.205 | 3.89 |
| 0.41 | 2.07 | 5.05 |
| 0.60 | 3.98 | 6.64 |
| 0.83 | 7.65 | 9.22 |
| 1.12 | 11.92 | 10.65 |

Water and Xylene.

| Millimols. per liter | | |
|---|---|---|
| $H_2O$ layer ($C_1$) | $C_6H_5(CH_3)_2$ layer ($C_2$). | $\frac{C_2}{C_1}$. |
| 23.55 | 0.40 | 0.017 |
| 30.50 | 0.61 | 0.020 |
| 37.50 | 0.95 | 0.024 |

## DI NITRO TOLUENE 2,4 $CH_3.C_6H_3.(NO_2)_2$.

### Solbbility of Dinitro Toluene in Water and in Other Solvents.

(Desvergnes, 1925.)

| Solvent | t° | Gms. $CH_3C_6H_3(NO_2)_2$ per 100 gms. solvent | Solvent | t° | Gms. $CH_3C_6H_3(NO_2)_2$ per 100 gms. solvent |
|---|---|---|---|---|---|
| Water | 22 | 0.027 | $C_6H_6$ | 15 | 60.64 |
| " | 50 | 0.037 | $CHCl_3$ | 15 | 65.08 |
| " | 100 | 0.254 | $(C_2H_5)_2O$ | 15 | 9.42 |
| $CH_3COOC_2H_5$ | 15 | 57.93 | $C_5H_5N$ | 15 | 76.80 |
| $(CH_3)_2CO$ | 15 | 81.90 | $CS_2$ | 15 | 2.31 |
| $CH_3OH$ | 15 | 5.01 | $CCl_4$ | 15 | 2.43 |
| $C_2H_5OH$(96%) | 15 | 1.92 | $C_6H_5CH_3$ | 15 | 45.47 |
| " (100%) | 15 | 3.04 | | | |

100 gms. sat. solution of dinitro toluene in liquid sulfur dioxide contain 40 gms. $CH_3.C_6H_3(NO_2)_2$ at ? t°. (DeCarli, 1927.)

Freezing-point data are given for mixtures of Dinitro Toluenes and:

Acenaphthene(24)(26)(10)
Aniline(24)(21)
Anthracene(24)(25)
Azobenzene(14)
Azoxybenzene(13)
Benzene(22)
Benzoic acid(6)
Carbazole(28)
Diethyl diphenyl urea(13)
Dimethyl amino azo benzene(14)
Dinitro benzene(10)(16)(17)(18)
Dinitro toluenes(15)(9)(10)
Diphenyl amine(10)(31)
Fluoranthene(33)
Fluorene(24)
Hydroquinol dimethylic ether(12)
Naphthalene(20)(30)
Naphthylamines(24)(36)
Naphthol(12)
Naphthol methyl ether(12)
Nitro mannite(34)
Nitro penta erythrite(34)
Nitro toluenes(1)(2)(3)(8)(5)(9)(10)(15)
Oxy benzaldehyde(29)
Pyrene(33)
Picric acid(35)
Salicylic acid(7)
Toluidines(27)(24)
Trinitro toluenes(3)(8)(4)(11)(35)(9)(10)(16)(18)(5)(17)
Trinitro phenol(17)
Trinitro phenyl methyl nitramine(19)
Trinitro xylene(4)
Triphenyl carbinol(23)
Urea(27)(32)
Phenanthrene(37)(38)

(1) Bell and Cordon, 1921; (2) Bell, Cordon, Spry and White, 1921; (3) Bell and Herty Jr., 1919; (4) Bell and Sawyer, 1919; (5) Bogoiavlenslenski, 1918, 1928; (6) Crockford and Hughes, 1930; (7) Crockford and Zurburg, 1930; (8) Giua, 1913; (9) Giua, 1914; (10) Giua, 1915; (11) Giua, 1920; (12) Giua and Marcellino, 1920; (13) Giua and Guastalla, 1925; (14) Giua and Reggiani, 1925; (15) Gibson, Duckham and Fairbairn, 1922; (16) Hrynakowski, 1934; (17) Hrynakowski and Kapuscinski, 1933b; (18) Hrynakowski and Kapuscinski, 1934; (19) Jefremow and Tichomirowa, 1926; (20) Kremann, 1904; (21) Kremann, 1906; (22) Kremann, 1908; (23) Kremann, Hohl and Muller II, 1921; (24) Kremann, Hönigsberg and Mauermann, 1923; (25) Kremann and Müller II, 1921; (26) Kremann and Haas, 1919; (27) Kremann and Petritschak, 1917; (28) Kremann and Strzelba, 1921; (29) Kremann and Pogantsch, 1923; (30) Kremann and Rodinis, 1906; (31) Rheinboldt, 1926; (32) Rheinboldt and Kirscheisen, 1926; (33) Shinomiya, 1940; (34) Urbanski, 1934; (35) Wogrinz and Vari, 1919; (36) Kremann and Grasser, 1916. (37) Kremann et. al., 1908. (38) Kremann and Hofmeier, 1910.

### Coefficients of Distribution of Dihydroxy and Trihydroxy Benzoic Acids Between Water and Olive Oil.

(Boeseken and Waterman, 1911.)

| Acid | Coef. of Distribution |
|---|---|
| 2.4 Dihydroxy Benzoic Acid | 1.0 |
| 2.5 " " " | 0.3 |
| 3.4 " " " | 0.05 |
| 3.4.5 Trihydroxy Benzoic Acid | 0.025 |

## Aminonitro**BENZOIC ACIDS** $C_6H_3.NO_2.NH_2.COOH$ *o*, *m* and *p*.

### Solubility of the Three Isomeric Aminonitrobenzoic Acids:

| | In Ether. Gms. $C_6H_3.NO_2.NH_2.COOH$ per 100 cc. Ether. | | | | In Ethyl Alcohol (90%). Gms. $C_6H_3NO_2.NH_2.COOH$ per 100 cc. Alcohol. | | |
|---|---|---|---|---|---|---|---|
| t°. | Ortho. | Meta. | Para. | t°. | Ortho. | Meta. | Para. |
| 2.7 | 10.84 | 1.70 | 6.41 | 3 | 8.13 | 1.79 | 8.4 |
| 5.8 | 16.05 (6.8°) | 1.81 | 8.21 | 9.6 | 10.70 | 2.20 | 11.3 |

## **GALLIC ACID** 3.4.5, $(OH)_3C_6H_2COOH.H_2O$.

### Solubility in Aqueous Ethyl Alcohol at 25°.

(Seidell, 1910.)

| Wt. Per Cent $C_2H_5OH$ in Solvent. | $d_{25}$ of Sat. Sol. | Gms. $C_6H_2(OH)_3COOH.H_2O$ per 100 Gms. Sat. Sol. | Wt. Per Cent $C_2H_5OH$ in Solvent. | $d_{25}$ of Sat. Sol. | Gms. $C_6H_2(OH)_3COOH.H_2O$ per 100 Gms. Sat. Sol. |
|---|---|---|---|---|---|
| 0 | 1.002 | 1.15 | 60 | 0.957 | 16 |
| 10 | 0.992 | 2 | 70 | 0.946 | 18 |
| 20 | 0.983 | 4.2 | 80 | 0.933 | 19.9 |
| 30 | 0.977 | 7.5 | 90 | 0.919 | 21.2 |
| 40 | 0.972 | 10.6 | 95 | 0.911 | 21.6 |
| 50 | 0.965 | 13.4 | 100 | 0.902 | 22.2 |

100 gms. $H_2O$ dissolve 0.95 gm. gallic acid at 15°. (Greenish and Smith, 1903.)
100 gms. $H_2O$ dissolve 33.3 gms. gallic acid at 100°. (U. S. P. VIII)

### Distribution of Gallic Acid at 25° Between: (Smith, 1921-1922.)

| Water and Ether. Millimols. per liter | | | Acetone and Glycerol. Millimols. per liter | | |
|---|---|---|---|---|---|
| $H_2O$ layer ($C_1$). | $(C_2H_5)_2O$ layer ($C_2$). | $\frac{C_2}{C_1}$. | Acetone layer (A). | Glycerol layer (G) | $\frac{A}{G}$. |
| 2.82 | 1.27 | 0.451 | 0.8625 | 2.45 | 0.352 |
| 8.25 | 3.72 | 0.452 | 2.325 | 6.625 | 0.351 |
| 15.75 | 7.13 | 0.452 | 4.45 | 12.85 | 0.346 |
| 35.2 | 16.10 | 0.457 | 9.55 | 29.85 | 0.320 |
| 59.5 | 27.0 | 0.453 | | | |

### Solubility of Gallic Acid in Organic Solvents at 25°.

(Seidell, 1910.)

| Solvent. | Density of Solvent. | $d_{25}$ of Sat. Solution. | Gms. $C_6H_3(OH)_3COOH.H_2O$ per 100 Gms. Sat. Sol. |
|---|---|---|---|
| Acetone | $d_{15} = 0.797$ | 0.941 | 25.99 |
| Amylalcohol (iso) | $d_{20} = 0.817$ | 0.834 | 5.39 |
| Amylacetate | $d_{20} = 0.875$ | 0.878 | 2.72 |
| Benzene | $d_{25} = 0.873$ | 0.875 | 0.022 |
| Carbon Disulfide | $d_{25} = 1.258$ | 1.262 | 0.042 |
| Ether (abs.) | $d_{20} = 0.711$ | 0.718 | 1.370 |
| Ethylacetate | $d_{25} = 0.892$ | 0.911 | 3.610 |

The amount of gallic acid dissolved by carbon tetrachloride, chloroform and toluene was too small for estimation.

100 gms. glycerol dissolve 8.3 gms. $C_6H_2(OH)_3COOH.H_2O$ at 25°. (U. S. P. VIII.)
100 gms. 95% formic acid dissolve 0.56 gm. gallic acid at 19.4°. (Aschan, 1913.)

1.2.4 Dinitr**ANISOLE** $(NO_2)_2C_6H_3.OCH_3$ 1.2.4.

Solubility in Several Solvents.

(Desvergnes, 1924.)

Commercial dinitranisole was dissolved in twice its weight of nitric acid ($d = 1.40$) and after 24 hours the crystals were washed with cold nitric acid, with water and finally with alcohol. The m. pt. was 94°.58.

| Solvent. | t°. | Gms. $(NO_2)_2C_6H_3OCH_3$. per 100 gms. solvent. |
|---|---|---|
| Water..... | 15 | 0.0155 |
| » ..... | 50 | 0.0136 |
| » ..... | 100 | 0.4780* |
| Ethyl acetate ($d_{15} = 0.9048$)... | 15 | 25.07 |
| | 50 | 78.63 |
| Acetone ($d_{15} = 0.7998$)... | 15 | 85.66 |
| | 50 | 218.97 |
| Ethyl alcohol (96°) ($d_{15} = 9.8112$)... | 15 | 1.887 |
| | 50 | 6.448 |
| Ethyl alcohol (abs.) ($d_{15} = 0.7967$)... | 15 | 2.997 |
| | 50 | 7.185 |
| Benzene ($d_{15} = 0.8826$)... | 15 | 30.27 |
| | 50 | 128.43 |
| Chloroform ($d_{15} = 1.4887$)... | 15 | 34.00 |
| | 50 | 102.96 |
| Ether (anhy.) ($d_{15} = 0.7193$)... | 15 | 3.821 |
| | 33 | 6.780 |
| Pyridine ($d_{15} = 0.9805$)... | 15 | 73.51 |
| | 50 | 198.98 |
| $CS_2$ ($d_{15} = 1.2723$)... | 15 | 0.356 |
| | 37 | 0.889 |
| $CCl_4$ ($d_{15} = 1.6012$)... | 15 | 0.356 |
| | 50 | 1.196 |
| Toluene ($d_{15} = 0.8733$)... | 15 | 16.63 |
| | 50 | 79.57 |

* At this temperature water saponifies the dinitranisole yielding the corresponding dinitrophenol.

Freezing-point data for mixtures of 1.3.5 dinitro anisole with nitro mannite and with nitro erythrite are given by Urbański, 1933.

TRITOLYL ARSINE $As(C_6H_4CH_3)_3$.

Freezing-point data for mixtures of tritolyl arsine and iodo toluene are given by Peat, 1925.

BROMO, CHLORO etc. TOLUENES $BrC_6H_4CH_3$.

Freezing-point data are given for mixtures of:

Bromo toluene + Benzene(7)
" " + Chloro toluene(2)
" " + Bromo toluene(3)
" " + Di bromo benzene(1)
" " + Ethylene bromide(7)
" " + Ethyl succinimide(7)
" " + Phenol(7)
" " + Tri benzylamine(7)
" " + Thymol(7)
" " + Veratrol(7)
" " + Xylene(7)

Chloro toluene + Bromo benzene(8)
" " + Bromo toluene(2)
" " + Chloro benzene(4)(5)
" " + Chloro toluene(9)
" " + Di chloro benzene(8)
" " + Fluoro benzene(8)
" " + Fluoro toluene(2)
" " + Toluene
Fluoro toluene + Chloro toluene(2)
" " + Toluene(2)
Iodo toluene + Tri p tolylarsine(6)

(1) Borodowski and Bogojawlenski, 1904; (2) Jänecke and Rahlfs, 1932; (3) Van der Laan, 1907; (4) Linard, 1925; (6) Peat, 1925; (7) Paterno and Ampola, 1897; (8) Timmermans, 1934; (9) Wahl, Normand and Vermeylen, 1922.

BENZYL CHLORIDE $C_6H_5CH_2Cl$.

Freezing-point data for mixtures of benzyl chloride with methyl aniline and with anisole are given by Wroczynski and Guye, 1910.

## DIBROMO m TOLUIDINES $Br_2.C_6H_2.CH_3.NH_2$.

Freezing-point data for mixtures of 2.6 di bromo and 4.6 di bromo meta toluidines are given by Olivier, 1925.

## TOLUOL DIAZONIUM PHOSPHOR HEXA FLUORIDE $CH_3.C_6H_4.N_2.PF_6$.

100 gms. $H_2O$ dissolve 0.013 gm. mol. $C_7H_7N_2PF_6$ at 0°. (Lange and Müller, 1930.)

## BENZAMIDE $C_6H_5CONH_2$.

### Solubility of Benzamide in Mixtures of Alcohol and Water at 25°.

(Holleman and Antusch — Rec. trav. chim. 13, 294, '94.)

| Vol. % Alcohol. | Gms. $C_6H_5CONH_2$ per 100 Gms. Solvent. | Sp. Gr. of Solutions. | Vol. % Alcohol. | Gms. $C_6H_5CONH_2$ per 100 Gms. Solvent. | Sp. Gr. of Solutions. |
|---|---|---|---|---|---|
| 100 | 17.03 | 0.830 | 70 | 23.87 | 0.925 |
| 95 | 21.12 | 0.856 | 60 | 18.98 | 0.939 |
| 90 | 24.50 | 0.878 | 50 | 13.74 | 0.949 |
| 85 | 26.15 | 0.895 | 40 | 8.62 | 0.958 |
| 83 | 26.63 | 0.900 | 31 | 5.33 | 0.967 |
| 80 | 26.43 | 0.907 | 15 | 2.28 | 0.982 |
| 75 | 25.41 | 0.917 | 0 | 1.35 | 0.999 |

See remarks under α Acetnaphthalide, p. 705.

100 gms. pyridine dissolve 31.23 gms. benzamide at 20°–25°. (Dehn, 1917.)
100 gms. aq. 50% pyridine dissolve 39.15 gms. benzamide at 20°–25°. "
The coefficient of distribution of benzamide between oil and water is 0.66 at 3° and 0.43 at 36°. (Meyer, 1901, 1909.)

100 gms. sat. solutionsof benzamide in liquid ammonia contain 35 gms. $C_6H_5CONH_2$ at ? t°.

100 gms. sat. solution of benzamide in liquid sulfur dioxide contain 17 gms. $C_6H_5CONH_2$ at ? t°. (DeCarli, 1927.)

## BENZAMIDE $C_6H_5CONH_2$.

### Solubility of Benzamide in Ethyl Alcohol. (Spoyers, 1902)

| t°. | d. of sat. sol. | Gm. mol. $C_6H_5CONH_2$ per 100 G.M. sat. sol. | Gms. $C_6H_5CONH_2$ per 100 gms. $C_2H_5OH$. | t°. | d. of sat. sol. | Gm. mol. $C_6H_5CONH_2$ per 100 G.M. sat. sol. | Gms. $C_6H_5CONH_2$ per 100 gms. $C_2H_5OH$. |
|---|---|---|---|---|---|---|---|
| 0.0.. | 0.833 | 3.1 | 8.35 | 40... | 0.848 | 11.5 | 33.0 |
| 10.0.. | 0.832 | 4.2 | 11.5 | 50... | 0.862 | 14.2 | 43.5 |
| 20.0.. | 0.833 | 6.2 | 16.0 | 60... | 0.881 | 17.2 | 54.5 |
| 25.0.. | 0.835 | 7.4 | 19.0 | 70... | 0.913 | 20.0 | 66.5 |
| 30.0.. | 0.838 | 8.8 | 23.0 | | | | |

### Solubility of Benzamide in Several Solvents.

| Solvent. | t°. | Gms $C_6H_5CONH_2$ per 100 gms. solvent. | Authority. |
|---|---|---|---|
| Water | 12 | 0.58 | (Oliveri-Mandala, 1926.) |
| 10.2 % aq. sol. of Antipyrine | 12 | 0.60 | » |
| Absolute alcohol | 20–25 | 17.03 | (Pucher and Dehn, 1921) |
| Quinoline | » | 6.27+ | » |
| Equi. mol. mixture of $C_2H_5OH$ + Quinoline. | » | 18.55+ | » |

SOLUBILITY OF BENZAMIDE IN MIXTURES OF ETHYL ALCOHOL AND WATER. (Pleuger, 1925.)

| Wt. per cent $C_2H_5OH$ in solvent. | Gms. $C_6H_5CONH_2$ per 100 gms. sat. solution at : | | | | |
|---|---|---|---|---|---|
| | 30°. | 50°. | 70°. | 90°. | 110°. |
| 0.0 (= $H_2O$)..... | – | 2.0 | 7.5 | 81.0 | 95.0 |
| 10.0..... | 2.0 | 5.5 | 36.0 | 82.5 | 94.5 |
| 30.0..... | 8.5 | 23.5 | 57.5 | 82.0 | 93.8 |
| 49.5..... | 17.0 | 37.0 | 62.0 | 81.0 | 93.0 |
| 65.8..... | 22.0 | 40.0 | 61.0 | 78.7 | 92.0 |
| 84.6..... | 22.0 | 37.0 | 56.0 | 75.0 | 91.0 |
| 100.0..... | 16.0 | 29.0 | 48.0 | 69.7 | 88.0 |

SOLUBILITY OF BENZAMIDE IN MIXTURES OF ETHYL ALCOHOL AND CARBON DISULFIDE. (Pleuger, 1925.)

| Wt. per cent $C_2H_5OH$ in solvent. | Gms. $C_6H_5CONH_2$ per 100 gms. sat. solution at : | | | | | |
|---|---|---|---|---|---|---|
| | 30°. | 50°. | 70°. | 90°. | 110°. | 120°. |
| 0.0 (= $CS_2$).. | – | – | – | – | 75.0 | 90.0 |
| 19.9..... | 6.5 | 14.0 | 28.0 | 55.0 | 81.5 | 92.0 |
| 38.0..... | 12.0 | 22.5 | 40.0 | 63.0 | 84.5 | 93.5 |
| 60.7..... | 14.5 | 27.5 | 46.5 | 67.7 | 86.7 | » |
| 79.2..... | 15.5 | 28.5 | 47.5 | 69.0 | 87.5 | » |
| 100.0..... | 16.0 | 29.0 | 48.0 | 69.7 | 88.0 | 95.5 |

SOLUBILITY OF BENZAMIDE IN MIXTURES OF ETHYL ALCOHOL AND CARBON TETRACHLORIDE. (Pleuger, 1925.)

| Wt. per cent $C_2H_5OH$ in solvent. | Gms. $C_6H_5CONH_2$ per 100 gms. sat. solution at : | | | | | |
|---|---|---|---|---|---|---|
| | 30°. | 50°. | 70°. | 90°. | 110°. | 120°. |
| 0.0 (= $CCl_4$).. | – | – | – | – | 45.0 | 85.5 |
| 19.8..... | 5.0 | 10.0 | 20.5 | 43.5 | 75.5 | 90.0 |
| 40.2..... | 9.0 | 18.0 | 33.5 | 56.0 | 81.0 | 92.5 |
| 60.7..... | 12.0 | 23.0 | 40.0 | 63.0 | 84.5 | 93.5 |
| 80.0..... | 14.5 | 26.5 | 45.0 | 67.5 | 86.5 | 94.5 |

Freezing-point data are given for mixtures of Benzamide and:

Acetic acid(3)
Acetic anhydride(3)
Benzoic acid(3)
Benzoic anhydride(3)
Dioxy benzenes(1)
Dioxy naphthalenes(2)
Naphthylamine(8)
Naphthols(1)
Nitro phenols(1)(7)
Nitroso dimethyl aniline(6)(7)
Oxy benzoic acids(1)
Phenol(4)
Pyrogallol(5)

(1) Kremann and Auer, 1918; (2) Kremann, Hemmelmayr and Reimer, 1922; (3) Kremann, Mauermann and Oswald, 1923; (4) Kremann and Wenzing, 1917; (5) Kremann and Zechner, 1924; (6) Kremann and Wlk, 1919; (7) Puschin and Rikovski, 1930; (8) Rheinboldt, Henning and Kirscheisen, 1925.

## BENZAL DOXIMES $C_6H_5CH:NOH$.

Freezing-point data are given for mixtures of benzaldoximes by Cameron, 1898. Results for mixtures of benzaldoxime and di nitro chloro benzene are given by Brady and Truszkowski, 1924. Results for mixtures of α and β Nitro benzaldoximes are given by Beck, 1904. Results for mixtures of Hydroxy and Methoxy benzaldoximes with di nitro chloro benzene are given by Brady and Truskowski, 1924.

## NITROSO TOLUENE $NOC_6H_4CH_3$.

Freezing-points of mixtures of nitroso toluene with nitroso benzene, nitroso mesitylene and nitroso m xylene are given by Hammick, Edwards, Illingworth and Snell, 1933.

## NITROSO ANISOLE $NOC_6H_4OCH_3$.

Freezing-points of mixtures of nitroso anisole with bromo nitroso benzene, nitroso mesitylene and tri bromo nitroso benzene, are given by Hammick, Edwards, Illingworth and Snell, 1933.)

## Nitro**TOLUENE** *o* $C_6H_4.CH_3.NO_2$.

### Reciprocal Solubility of *o* Nitrotoluene and Water.

(Campetti and Delgrosso, 1913.)

The original results were plotted and the following figures read from the curve.

| t°. | Gms. *o* Nitrotoluene per 100 Gms. $H_2O$ Rich Layer. | Gms. *o* Nitrotoluene per 100 Gms. Nitrotoluene Rich Layer. | t°. | Gms. *o* Nitrotoluene per 100 Gms. $H_2O$ Rich Layer. | Gms. *o* Nitrotoluene per 100 Gms. Nitrotoluene Rich Layer. |
|---|---|---|---|---|---|
| 150 | 1 | 98 | 245 | 13 | 81 |
| 175 | 1.5 | 96 | 250 | 16 | 78 |
| 200 | 3 | 93 | 255 | 20 | 72 |
| 225 | 6.5 | 89 | 260 | 29 | 63 |
| 240 | 10.5 | 84 | 263.5 crit. t. | 43 | |

100 gms. 95 per cent formic acid dissolve 13.25 gms. *p* $C_6H_4.CH_3.NO_2$ at 20.8°.
(Aschan, 1913.)

### Solubility of o, m, and p, Nitro Toluenes, Each Separately, Water at 30°.

(Gross, Saylor and Gorman, 1933.)

| Compound | m. pt. | Gms. Compound per 1000 gms. $H_2O$ |
|---|---|---|
| Ortho Nitro toluene | 9.55 | 0.652 |
| Meta " " | 15.44 | 0.498 |
| Para " " | 51.4 | 0.442 |

### Solubility of Para Nitro Toluene in Water and Other Solvents.

(Desvergnes, 1925.)

| Solvent | t° | Gms. p $NO_2C_6H_4CH$ per 100 gms. solvent | Solvent | t° | Gms. p $NO_2.C_6H_4.CH_3$ per 100 gms. solvent |
|---|---|---|---|---|---|
| Water | 14.5 | 0.004 | $C_6H_6$ | 15 | 127.64 |
| " | 50.0 | 0.0078 | $(C_2H_5)_2O$ | " | 80.83 |
| " | 100.0 | 0.0116 | $CHCl_3$ | " | 105.02 |
| $CH_3COOC_2H_5$ | 15 | 91.13 | $C_5H_5N$ | " | 90.27 |
| $(CH_3)_2CO$ | " | 168.51 | $CS_2$ | " | 72.57 |
| $CH_3OH$ | " | 13.7 | $CCl_4$ | " | 42.63 |
| $C_2H_5OH$(96%) | " | 8.58 | $C_6H_5CH_3$ | " | 104.95 |
| $C_2H_5OH$(100%) | " | 16.64 | | | |

Nitro **TOLUENE**

100 gms. sat. solution of o nitro toluene in liquid sulfur dioxide contain 85 gm. o $NO_2C_6H_4CH_3$ at ? t°. (DeCarli, 1927.)

The calculated critical solution temperature of mixtures of meta nitro toluene and hexane is -30°. (Dessart, 1926.)

Freezing-point data are given for mixtures of Nitro toluenes and:

Amino azo benzene(18)
Aniline(24)
Azo benzene(18)
Benzene(12)(25)
Benzoic acid(19)
Benzo phenone + dibenzyl (27)
Bromo nitro benzene(19)
Chloro nitro benzene(19)
Cyclohexane(12)(25)
Dibenzyl + benzo phenone (27)
Diethyl diacetyl tartrate (31)
Diethyl diphenyl urea(17a)
Dimethyl amino azobenzene (18)
Dinitro benzenes(16)
Dinitro toluenes(3)(6)(8)(13)(4)(16)(2)(21)(31)(14)(15)
Diphenyl amine(16)
Hexane(12)
Methyl cyclohexane(12)
Methylene dioxybenzal aceto phenone(1)
Naphthalene(24)(10)
Nitro aniline(19)
Nitro erythritol(28)
Nitro mannitol(28)
Nitro penta erythritol (28)
Nitro phenol(10)
Nitro toluenes(4)(5)(13)(3)(20)(22)
Salicylic acid(11)
Toluene(12)
Toluidine(10)
Tetra nitro methyl aniline(16)
Tri methylene-tri nitramine(29)
Tri nitro toluene(3)(6)(7)(16)(17)(2)
Tri nitro phenyl-methyl nitramine(15)(23)
Tri nitro m xylene(8)
Urethan(26)

(1) Aschina, 1934; (2) Bogoiavienslenskii, 1918, 1928; (3) Bell and Cordon, 1912; (4) Bell, Cordon, Spry and White, 1921; (5) Bell and McEwen, 1922; (6) Bell and Herty, Jr., 1919; (7) Bell and Spry, 1921; (8) Bell and Sawyer, 1919; (9) Crockford and Hughes, 1930; (10) Crockford and Simmons, Jr., 1933; (11) Crockford and Zurburg, 1930; (12) Dessart, 1926; (13) Gibson, Duckham and Fairbairn, 1922; (14) Giua, 1913; (15) Giua, 1914; (16) Giua, 1916; (17) Giua, 1920; (17a) Giua and Guastalla, 1933; (18) Giua and Reggiani, 1925; (19) Grimm, Gunther and Titus, 1931; (20) Holleman, 1914; (21) Holleman, Vermeulen and de Mooy, 1914; (22) Holleman and van der Arend, 1909; (23) Jefremow, 1926; (24) Kremann, 1904; (25) Linard; (26) Mascarelli, 1908, 1909; (27) Malotaux and Sraub, 1937; (28) Urbanski, 1933; (29) Urbanski and Rabek-Gawronska, 1934; (30) Scheuer, 1910; (31) Vermeulen, 1928.

## Amino**BENZOIC ACID** (*m*) $C_6H_4.NH_2.COOH$.

SOLUBILITY OF META AMINO BENZOIC ACID IN WATER AND IN OTHER SOLVENTS.
(de Coninck, 1893.)

In Water.

| t°. | Gms. $C_6H_4.NH_2.COOH$(*m*) per 100 cc. $H_2O$. |
|---|---|
| 0 | 0.43 |
| 10 | 0.52 |
| 20 | 0.67 |
| 30 | 0.87 |
| 40 | 1.15 |
| 50 | 1.50 |
| 60 | 2.15 |
| 70 | 3.15 |

In Organic Solvents.

| Solvent. | t°. | Gms. $C_6H_4.NH_2.COOH$(*m*) per 100 cc. Solvent. |
|---|---|---|
| Ethyl Alcohol (95%) | 12.5 | 2.92 |
| Methyl Alcohol (pure) | 10.5 | 4.05 |
| Acetone | 11.3 | 6.22 |
| Methyl Iodide | 10.0 | 0.04 |
| Ethyl Iodide | 0.0 | 0.02 |
| Chloroform | 12.0 | 0.07 |
| Bromoform | 8.0 | trace |

## Amino**BENZOIC ACID** (*o*) $C_6H_4.NH_2.COOH$.

Solubility of *o* Aminobenzoic Acid in Water. (Lunden, 1905–06.)

| t° | Sp. Gr. Sat. Sol. | Gms. $C_6N_4NH_2COOH(o)$ per 100 cc. Sat. Sol. | t°. | Sp. Gr. Sat. Sol. | Gms. $C_6H_4NH_2COOH(o)$ per 100 cc. Sat. Sol. |
|---|---|---|---|---|---|
| 25 | 0.999 | 0.519 | 34.9 | 0.998 | 0.731 |
| 26.1 | ... | 0.540 | 35 | 0.997 | 0.744 |
| 28.1 | ... | 0.570 | 39.8 | 0.997 | 0.889 |

Mutual Solubility of Aminobenzoic Acids and Water at High Temperatures, Determined by the Synthetic Method.
(Flaschner and Rankin, 1910.)

| Mixtures of *o* Acid and $H_2O$. | | Mixtures of *m* Acid and $H_2O$. | | Mixtures of *p* acid and $H_2O$. | |
|---|---|---|---|---|---|
| t° of Melting. | Gms. *o* Acid per 100 Gms. Mixture. | t° of Melting. | Gms. *m* Acid per 100 Gms. Mixture. | t° of Melting. | Gms. *p* Acid per 100 Gms. Mixture |
| 83.6 | 4.8 | 66 crit. sol. temp. | | 47 crit. sol. temp. | |
| 95.8 | 9.9 | 77.8 | 4.6 | 82.2 | 5 |
| 101.4 | 18.5 | 90 | 5.8 | 90 | 7.1 |
| 103.4 | 30.6 | 100 | 9.7 | 100 | 15.8 |
| 104.4 | 38 | 110 | 20.2 | 105 | 22 |
| 105 | 49.4 | 120 | 51.2 | 110 | 32.3 |
| 105.6 | 59.4 | 130 | 73.7 | 116 | 51.8 |
| 107.8 | 69.7 | 140 | 83.7 | 120 | 62 |
| 112 | 80 | 150 | 90.7 | 130 | 77 |
| 116.2 | 87.2 | 160 | 95.8 | 150 | 91.1 |
| 128.4 | 95 | 170 | 99.2 | 170 | 98 |
| 144.6 | 100 | 174.4 | 100 | 186 | 100 |

$t°$ reading, for critical saturation and for separating, also given in the case of the *o* acid.

Solubility of Aminobenzoic Acid in Aqueous Salt Solutions at 25°.
(Lunden, 1905–06.)

| Normality of Salt Solution. | | Sp. Gr. Sat. Solution. | Gms. $C_6H_4NH_2COOH(o)$ per 100 cc. Sat. Solution. | Normality of Salt Solution. | | Sp. Gr. Sat. Solution. | Gms. $C_6H_4NH_2COOH(o)$ per 100 cc. Sat. Sol. |
|---|---|---|---|---|---|---|---|
| 0.768 | $\frac{1}{2}Ba(NO_3)_2$ | 1.080 | 0.634 | 2.633 | $KNO_3$ | 1.155 | 0.501 |
| 0.507 | " | 1.052 | 0.603 | 1.372 | " | 1.083 | 0.544 |
| 0.3427 | " | 1.037 | 0.585 | 0.598 | " | 1.033 | 0.549 |
| 0.1780 | " | 1.018 | 0.555 | 1.853 | KI | 1.221 | 0.541 |
| 0.1545 | " | 1.015 | 0.549 | 0.946 | " | 1.114 | 0.559 |
| | | | | 0.560 | " | 1.068 | 0.556 |

The author also gives additional data for aqueous salt solutions at 28.1°.
Additional data for the solubility of aminobenzoic acid in aqueous salt solutions are given by Euler (1916).

## Amino **BENZOIC ACID** (*m*) $C_6H_4 NH_2.COOH$.

Solubility in Water and in Aqueous Solutions of Sodium Chloride and of Potassium Nitrate at 25°. (de Szyszkowski, 1914-1915.)

| Normality of Aq. salt solution. | Gm. mols. *m* $C_6H_4.NH_2.COOH$ per 1000 gms. sat. sol. in: Aqueous NaCl. | Aqueous $KNO_3$. |
|---|---|---|
| 0.0 (= water) | $5.565.10^{-2}$ | $5.565.10^{-2}$ |
| 0.1 | — | 5.606 » |
| 0.25 | 5.670 » | 5.797 » |
| 0.5 | 5.712 » | 5.802 » |
| 1.0 | 5.246 » | 5.064 » |

## ANTHRANILIC ACID (*o* Aminobenzoic Acid) *o* $NH_2C_6H_4COOH$.

### Distribution of Anthranilic Acid Between:
(Smith, 1921-22.)

**Water and Chloroform at 25°.**

| Millimols. *o* $NH_2C_6H_4CO\,OH$ per liter. | | |
|---|---|---|
| Water layer ($C_1$). | $CHCl_3$ layer ($C_2$). | $\frac{C_2}{C_1}$. |
| 4.50 | 0.60 | 0.133 |
| 6.62 | 0.96 | 0.145 |
| 10.00 | 1.54 | 0.154 |
| 16.10 | 2.87 | 0.178 |

**Water and Ether at 25°.**

| Millimols. *o* $NH_2C_6H_4CO\,OH$ per liter. | | |
|---|---|---|
| Water layer ($C_1$) | Ether layer ($C_2$). | $\frac{C_2}{C_1}$. |
| 0.52 | 0.56 | 1.075 |
| 1.00 | 1.05 | 1.05 |
| 1.86 | 2.21 | 1.19 |
| 3.57 | 4.04 | 1.13 |
| 6.04 | 6.80 | 1.125 |

**Water and Acetone at 25°.**

| Millimols. *o* $NH_2C_6H_4COOH$ per liter. | | |
|---|---|---|
| Glycerol layer (G). | Acetone layer (A) | $\frac{A}{G}$. |
| 1.05 | 2.20 | 2.09 |
| 1.55 | 3.80 | 2.45 |
| 3.20 | 8.95 | 2.80 |
| 4.60 | 14.70 | 3.20 |

Data for the distribution of *o* aminobenzoic acid between water and benzene at 25° are given by Farmer and Warth (1904).

### Distribution of Anthranilic Acid Between Water and Chloroform at 25°.
(Smith and White, 1929.)

| Gm. mols. o $NH_2C_6H_4COOH$ per liter | |
|---|---|
| $H_2O$ layer | $CHCl_3$ layer |
| 0.01126 | 0.00176 |
| 0.01607 | 0.00306 |
| 0.02092 | 0.00479 |
| 0.02735 | 0.00766 |
| 0.03250 | 0.01038 |
| 0.04698 | 0.01996 |

100 gms. Cymene dissolve 0.747 gms. Anthranilic acid at 25°. (Wheeler, 1920.)

### Solubility of Ortho Amino Benzoic Acid in Several Solvents.
(Lazzell and Johnston, 1928.)

The determinations at 25° were made by the analytical method and all others by the synthetic method. The results were plotted and the following results taken from the curves.

| t° | Gm. Mol. o $NH_2C_6H_4COOH$ per 100 gm. mols. sat. solution in: | | | | | |
|---|---|---|---|---|---|---|
| | $CH_3COOC_2H_5$ | $C_2H_5OH$ | $CH_3OH$ | Butyl alc. | $CHCl_3$ | $C_6H_6$ |
| 25 | 14.71 | 7.75 | 7.62 | — | 1.57 | 0.81 |
| 30 | 15.0 | 9.0 | 8.6 | — | 2.0 | 1.3 |
| 40 | 16.8 | 11.6 | 10.8 | — | 3.0 | 2.3 |
| 50 | 19.2 | 14.6 | 13.5 | — | 4.4 | 3.6 |
| 60 | 22.2 | 18.5 | 17.2 | — | 6.4 | 5.3 |
| 70 | 26.2 | 23.0 | 22.1 | — | 9.0 | 7.2 |
| 80 | 31.6 | 28.4 | 27.8 | 26.6 | 13.0 | 9.9 |
| 90 | 39.0 | 35.2 | 35.0 | 32.6 | 19.5 | 13.5 |
| 100 | 45.8 | 43.8 | 43.5 | 40.0 | 28.5 | 20.0 |
| 110 | 54.4 | 54.4 | 53.9 | 52.0 | 41.8 | 34.3 |
| 120 | 64.6 | 67.0 | 66.7 | 65.3 | 57.9 | 52.5 |
| 130 | 77.7 | 79.6 | 70.4 | 78.6 | 72.0 | 70.6 |
| 140 | 91.5 | 92.3 | 92.2 | 91.9 | 90.1 | 88.8 |

### Solubility of Meta Amino Benzoic Acid in Several Solvents.

(Lazzell and Johnston, 1928.)

| t° | Gm. Mol. m $NH_2C_6H_4COOH$ per 100 gm. mol. sat. solution in: | | | | | |
|---|---|---|---|---|---|---|
| | $CH_3OH$ | $C_2H_5OH$ | $CH_3COOC_2H_5$ | Butyl alc. | $CHCl_3$ | $C_6H_6$ |
| 25 | 1.70 | 1.52 | 1.30 | — | 0.05 | 0.008 |
| 30 | 2.2 | 1.8 | 1.4 | — | 0.3 | 0.2 |
| 40 | 3.4 | 2.5 | 1.6 | — | 0.7 | 0.4 |
| 50 | 4.6 | 3.2 | 1.8 | — | 1.1 | 0.7 |
| 60 | 5.7 | 4.0 | 2.0 | — | 1.5 | 1.0 |
| 70 | 7.0 | 4.6 | 2.5 | — | 1.9 | 1.3 |
| 80 | 8.6 | 6.0 | 3.3 | — | 2.2 | 1.6 |
| 90 | 10.8 | 8.4 | 4.7 | — | 2.5 | 1.8 |
| 100 | 15.0 | 12.7 | 6.8 | — | 2.8 | 2.2 |
| 110 | 20.3 | 19.7 | 11.4 | — | 3.1 | 2.4 |
| 120 | 27.9 | 27.0 | 19.2 | — | 3.4 | 2.7 |
| 130 | 37.5 | 37.3 | 28.4 | 22.4 | 4.8 | 3.6 |
| 140 | 48.7 | 47.4 | 30.8 | 30.6 | 9.5 | 5.9 |
| 150 | 61.0 | 59.0 | 54.6 | — | 23.3 | 12.1 |
| 160 | 73.9 | 72.8 | 70.9 | — | 68.9 | 59.7 |
| 170 | 88.0 | 88.0 | 87.1 | — | 88.0 | 88.0 |

### Solubility of Para Amino Benzoic Acid in Several Solvents.

(Lazzell and Johnston, 1928.)

| t° | Gm. Mol. p $NH_2C_6H_4COOH$ per 100 gms. mol. sat. solution in: | | | | | |
|---|---|---|---|---|---|---|
| | $CH_3OH$ | $C_2H_5OH$ | $CH_3COOC_2H_5$ | Butyl alc. | $CHCl_3$ | $C_6H_6$ |
| 25 | 5.94 | 4.97 | 5.1 | — | 0.13 | 0.04 |
| 30 | 6.6 | 5.4 | 5.4 | — | 0.2 | 0.2 |
| 40 | 8.2 | 6.5 | 6.0 | — | 0.4 | 0.3 |
| 50 | 9.6 | 7.8 | 7.0 | — | 0.7 | 0.4 |
| 60 | 11.4 | 9.5 | 8.1 | — | 1.0 | 0.6 |
| 70 | 13.4 | 11.8 | 9.7 | — | 1.2 | 0.7 |
| 80 | 15.8 | 14.8 | 11.7 | — | 1.5 | 0.8 |
| 90 | 19.0 | 18.4 | 14.3 | — | 1.8 | 1.0 |
| 100 | 22.9 | 22.4 | 17.7 | — | 2.1 | 1.2 |
| 110 | 27.7 | 27.3 | 22.0 | — | 2.4 | 1.4 |
| 120 | 33.8 | 33.1 | 27.8 | — | 2.6 | 2.0 |
| 130 | 41.1 | 40.4 | 35.4 | 28.7 | 3.0 | 3.0 |
| 140 | 49.8 | 49.7 | 44.4 | 39.3 | 7.2 | 5.0 |
| 150 | 59.6 | 59.9 | 54.8 | 51.1 | 18.3 | 10.0 |
| 160 | 70.1 | 70.8 | 66.3 | 63.7 | 38.0 | 30.3 |
| 170 | 80.9 | 81.6 | 78.8 | 76.7 | 73.8° | 68.4 |
| 180 | 97.0 | 92.4 | 91.3 | 90.3 | 92.3 | 90.0 |

Freezing-point data are given by Pfeiffer, Angern and Wang, 1927, for mixtures of ortho, meta and para amino benzoic acids, each separately with sarcosine anhydride.

## SALICYLAMIDE $OH.C_6H_4CONH_2$.

### Distribution Between Water and Olive Oil.

(Meyer, 1901.)

| t°. | Gms. $OHC_6H_4CONH_2$ per 100 cc. | | Dist. Coef. |
|---|---|---|---|
| | $H_2O$ Layer. | Oil Layer. | |
| 3 | 0.056 | 0.126 | 2.25 |
| 36 | 0.075 | 0.107 | 1.40 |

**PHENYL URETHAN** $NH_2COOC_6H_5$.

Freezing-point data for mixtures of phenyl urethan and antipyrine are given by Mazetti, 1926.

**CHLORO NITRO TOLUIDINES** $ClNO_2C_6H_2CH_3NH_2$.

Freezing-point data for mixtures (6) Chloro (4) nitro meta toluidine and (6) Chloro (3) nitro para toluidine are given by Morgan and Challenor, 1921.

**TOLUENE SULFONYL CHLORIDES** $CH_3.C_6H_4.SO_2Cl$.

Freezing-point data for mixtures of ortho and para toluene sulfonyl chlorides are given by Holleman and Caland, 1911, and by Harding, 1921.

**NITRO ANISOLES** o and p $NO_2C_6H_4OCH_3$.

1000 gms. $H_2O$ dissolve 1.69 gms. ortho anisole at 30°.
1000 gms. $H_2O$ dissolve 0.589 gms. para anisole at 30°. (Gross, Saylor and Gorman, 1933.)

Freezing-point data are given for mixtures of p Nitro anisole and:

Diphenyl amine(4)(5)
Mercuric chloride(2)(3)
Nitro mannitol(6)
Nitro penta erythritol(6)
Tri methylene tri nitramine(7)
Urethan(2)(5)

Results for mixtures of Di nitro anisole and Di nitro phenetol are given by (1).

(1) Blanksma, 1914; (2) Mascarelli, 1908, 1909; (3) Mascarelli and Ascoli, 1907; (4) Puschin, 1926b; (5) Puschin and Grebenschukov, 1913, 1925; (6) Urbanski, 1933; (7) Urbanski and Radek-Gawronska, 1934.

**AZOLITMINE** $C_7H_7NO_4$.

100 gms. $H_2O$ dissolve 39.5 gms. azolitmine at 20°–25°. (Dehn, 1917.)
100 gms. pyridine dissolve 0.05 gm. azolitmine at 20–25°. "
100 gms. aq. 50% pyridine dissolve 0.12 gm. azolitmine at 20°–25°. "

**TOLUENE** $C_6H_5CH_3$.

Solubility of Toluene in Water.

| t°. | Cc. $C_6H_5CH_3$ per 100 cc. $H_2O$. | Authority. | t°. | Cc. $C_6H_5CH_3$ per 100 cc. $H_2O$. | Authority. |
|---|---|---|---|---|---|
| 16..... | 0.057 | Fühner, 1924 | 150..... | 0.2 | Jaeger, 1923 |
| 25 (?).. | 0.063 | Horiba, 1917 | 200..... | 0.7 | » |
| 100..... | <0.10 | Jaeger, 1923 | 350..... | 2.8 | » |
| | | | 300 .... | 13.0 | » |

The determination of Fühner was made by adding the toluene from a buret to a measured volume of water untill saturation was reached. The determinations of Jaeger were made in a large shaking autoclave of more than two liters capacity. A measured volume of the saturated solution was cooled and after it had separated into two layers the volume of toluene was measured.

100 gms. $H_2O$ dissolve 0.057 gm. $C_6H_5CH_3$ at 30°. (Gross and Saylor, 1931.)

100 gms. $H_2O$ dissolve 0.0368 gm. $C_6H_5CH_3$ at 10° and 0.0492 gms. at 25°. (Uspenski, 1929.)

100 gms. sat. solution of toluene in 92 wt. per cent ethyl alcohol contain 88.0 gms. $C_6H_5CH_3$ at 15°. (Ormandy and Craven, 1921.)

### Solubility of Water in Toluene.

The results of Tarassenkow and Poloshinzewa, 1932; Rosenbaum and Walton, 1930 and of Uspenski, 1929, were plotted and the following values read from the curve.

| t° | Gms. $H_2O$ per 100 gms. sat. sol. | t° | Gms. $H_2O$ per 100 gms. sat. sol. | t° | Gms. $H_2O$ per 100 gms. sat. sol. |
|---|---|---|---|---|---|
| -10 | 0.02(0.002) | 25 | 0.050(0.045) | 60 | 0.15 |
| 0 | 0.027(0.007) | 30 | 0.057(0.052) | 70 | 0.21 |
| +10 | 0.035(0.020) | 40 | 0.075(0.075) | 80 | 0.275 |
| 20 | 0.045(0.035) | 50 | 0.10 | 90 | 0.375 |

The results in parentheses and above 50° are by Tarassenkow and Poloshinzewa.

## TOLUENE

100 gms. 0.4 normal aq. sodium oleate solution (= 10.8 gms. Na oleate per 100 gms. solution) dissolve 3.5 gms. $C_6H_5CH_3$ at 20°. When the oleic acid and toluene are mixed and the calculated amount of NaOH added to neutralize the oleic acid is added and the mixture diluted with water to 0.4 normality, the solubility of the toluene is 11.4 gms. $C_6H_5CH_3$ per 100 gms. sat. solution at 20°. (Smith, 1932.)

### Reciprocal Solubility of Toluene and Sulfur.

(Alexejew, 1886.)

The synthetic method was used. The results were plotted and the following values read from the curve.

| t°. | Gms. $C_6H_5CH_3$ per 100 Gms. | | t°. | Gms. $C_6H_5CH_3$ per 100 Gms | |
|---|---|---|---|---|---|
| | S Layer. | Toluene Layer. | | S Layer. | Toluene Layer. |
| 100 | 3 | 73 | 150 | 12.5 | 59 |
| 110 | 4 | 71 | 160 | 16 | 53 |
| 120 | 5 | 68 | 170 | 22 | 47 |
| 130 | 7 | 66 | 175 | 25 | 43 |
| 140 | 9.5 | 63 | 178 crit. temp. | 34 | |

Freezing-point data are given for mixtures of Toluene and:

Aniline(7)(8)
Benzene(5)
Benzoic acid(2)
Chloro toluene(4)
Cyclohexane(7)
Chloroform(7)
Ethylene bromide(1)
Fluoro toluenes(4)
Ethylidene chlorides(9)
Nitro toluene(3)
Toluidine(3)
Xylene(6)

(1) Baud, 1912; (2) Chipman, 1918; (3) Dessart, 1926; (4) Klemm, Klemm and Schiemann, 1933; (5) Mitsukari and Nakatsuchi, 1926; (6) Nakatsuchi, 1926; (7) Timmermans, 1928; (8) Timmermans, 1930; (9) Timmermans, 1934.

## Phenyl Thio**UREA** (Phenyl thiocarbamide) $CS.NH_2.NHC_6H_5$.

### Solubility in Water.

(Rothmund, 1900; Biltz, 1903; Hollman and Antusch, 1894; Bogdan, 1902–03.)

One liter aq. solution contains 2.12 gms. $CS(NH_2).NHC_6H_5$ at 20° (B.), (R.) and 2.4 gms. at 25°. (H. and A.). Bogdan gives 2.547 gms. at 25°.

### Solubility of Phenyl Thiourea at 25° in Aqueous Solutions of.

#### Potassium Nitrate.

(Bogdan, 1902–03.)

| Gms. Mols. $KNO_3$ per 1000 Gms. $H_2O$. | Gms. per 1000 Gms. $H_2O$. $KNO_3$. | Gms. per 1000 Gms. $H_2O$. $CS(NH_2).NHC_6H_5$. |
|---|---|---|
| 1.045 | 105.7 | 2.38 |
| 0.5123 | 51.84 | 2.48 |
| 0.2026 | 20.50 | 2.54 |
| 0.1007 | 10.19 | 2.56 |
| 0.0503 | 5.09 | 2.55 |
| 0.0333 | 3.36 | 2.55 |

#### Sodium Nitrate.

(Bogdan, 1902–03.)

| Gms. Mols. $NaNO_3$ per 1000 Gms. $H_2O$. | Gms. per 1000 Gms. $H_2O$. $NaNO_3$. | Gms. per 1000 Gms. $H_2O$. $CS(NH_2)NHC_6H_5$. |
|---|---|---|
| 1.024 | 87.14 | 2.26 |
| 0.5065 | 43.10 | 2.46 |
| 0.2031 | 17.28 | 2.51 |
| 0.0986 | 8.39 | 2.53 |
| 0.0540 | 4.59 | 2.54 |
| 0.0335 | 2.84 | 2.54 |

### Solubility of Phenyl Thiourea in Aqueous Salt Solutions at 20°.

(Biltz, 1903; Rothmund, 1900.)

| Salt Solution. | Millimols and the Equivalent Gms. $CS(NH_2)NHC_6H_5$ Dissolved per Liter of Aqueous Salt Solution of Concentration: 0.125 Normal Millimols. | 0.125 Normal Gms. | 0.25 Normal Millimols. | 0.25 Normal Gms. | 0.5 Normal. Millimols. | 0.5 Normal. Gms. | 1 Normal Millimols. | 1 Normal Gms. |
|---|---|---|---|---|---|---|---|---|
| $\frac{1}{3}AlCl_3$ | 12.95 | 1.97 | 12.82 | 1.96 | 12.03 | 1.83 | 10.69 | 1.61 |
| $NH_4NO_3$ | 14.17 | 2.15 | 14.4 | 2.21 | 14.53 | 2.22 | 14.91 | 2.27 |
| $\frac{1}{2}(NH_4)_2SO_4$ | 13.51 | 2.05 | 12.84 | 1.96 | 11.78 | 1.79 | 9.98 | 1.52 |
| $\frac{1}{2}BaCl_2$ | 13.12 | 1.99 | 12.92 | 1.97 | 12.22 | 1.86 | 10.44 | 1.59 |
| $\frac{1}{2}Ba(NO_3)_2$ | 13.98 | 2.13 | 13.98 | 2.13 | 13.90 | 2.12 | ... | ... |
| $CsNO_3$ | 14.53 | 2.21 | 14.90 | 2.27 | 15.23 | 2.33 | ... | ... |
| $LiNO_3$ | 13.96 | 2.13 | 13.96 | 2.13 | 13.93 | 2.12 | 13.73 | 2.10 |
| $\frac{1}{2}MgSO_4$ | 13.40 | 2.04 | 12.78 | 1.95 | 11.54 | 1.75 | 9.43 | 1.43 |
| $KC_2H_3O_2$ | 13.40 | 2.04 | 12.95 | 1.97 | 12.14 | 1.85 | 10.74 | 1.62 |
| KBr | 13.50 | 2.05 | 13.35 | 2.04 | 12.80 | 1.95 | 11.76 | 1.79 |
| $KClO_3$ | 13.86 | 2.11 | 13.60 | 2.06 | 13.12 | 1.99 | ... | ... |
| KCl | 13.40 | 2.04 | 12.73 | 1.94 | 12.19 | 1.85 | 10.54 | 1.60 |
| KI | 14.12 | 2.15 | 14.48 | 2.21 | 14.31 | 2.18 | 14.60 | 2.23 |
| $KNO_3$ | 13.89 | 2.12 | 13.85 | 2.11 | 13.52 | 2.05 | 12.82 | 1.96 |
| $KNO_2$ | 14.52 | 2.21 | 14.65 | 2.23 | 13.80 | 2.11 | 12.51 | 1.92 |
| $\frac{1}{2}K_2SO_4$ | 13.25 | 2.03 | 12.49 | 1.91 | 11.11 | 1.69 | 8.73 | 1.33 |
| $RbNO_3$ | 14.22 | 2.16 | 14.44 | 2.19 | 14.39 | 2.18 | 14.22 | 2.17 |
| $\frac{1}{2}Na_2CO_3$ | 13.29 | 2.04 | 12.52 | 1.91 | 11.05 | 1.68 | 8.58 | 1.32 |
| $NaClO_3$ | 13.75 | 2.09 | 13.65 | 2.08 | 13.07 | 1.98 | 12.21 | 1.86 |
| $NaClO_4$ | 14.15 | 2.15 | 14.05 | 2.14 | 13.58 | 2.06 | 12.56 | 1.92 |
| NaCl | 13.28 | 2.02 | 12.83 | 1.95 | 11.90 | 1.81 | 10.02 | 1.52 |
| NaI | 13.98 | 2.13 | 14.07 | 2.14 | 14.29 | 2.18 | 13.96 | 2.13 |
| $NaNO_3$ | 13.94 | 2.12 | 13.77 | 2.10 | 13.32 | 2.04 | 12.57 | 1.92 |
| $NaNO_2$ | 14.34 | 2.18 | 13.82 | 2.11 | 13.06 | 1.98 | 11.52 | 1.75 |
| $\frac{1}{2}Na_2SO_4$ | 13.19 | 2.00 | 12.35 | 1.87 | 10.85 | 1.63 | 8.30 | 1.27 |

## Solubility of Phenyl Thiourea in Ethyl Alcohol Solutions of Several Salts at 28°.

(Thorin, 1915.)

| Salt. | Normality of Salt in $C_2H_5OH$. | Mols. $NH_2.CS.NHC_6H_5$ per 100 Gms. Sat. Sol. | Salt. | Normality of Salt in $C_2H_5OH$. | Mols. $NH_2.CS.NH.C_6H_5$ per 100 Gms. Sat. Sol. |
|---|---|---|---|---|---|
| None | (pure $C_2H_5OH$) | 0.2065 | NaI | 0.043 | 0.2102 |
| LiCl | 0.168 | 0.2274 | " | 0.086 | 0.2148 |
| " | 0.337 | 0.2360 | " | 0.172 | 0.2198 |
| " | 0.673 | 0.2440 | " | 0.343 | 0.2271 |
| " | 1.346 | 0.2494 | " | 0.685 | 0.2359 |
| $CaCl_2$ | 0.061 | 0.2101 | NaBr | 0.022 | 0.2098 |
| " | 0.122 | 0.2135 | " | 0.043 | 0.2194 |
| " | 0.244 | 0.2194 | " | 0.086 | 0.2165 |
| " | 0.487 | 0.2279 | " | 0.172 | 0.2257 |
| " | 0.975 | 0.2372 | | | |

## Solubility of Phenyl Thiourea in Mixtures of Ethyl Alcohol and Water at 25°.

(Holleman and Antusch, 1894.)

| Vol. per cent Alcohol. | Gms. $CS(NH_2)NHC_6H_5$ per 100 Gms. Solvent. | Sp. Gr. of Solutions. | Vol. per cent Alcohol. | Gms. $CS(NH_2)NHC_6H_5$ per 100 Gms. Solvent. | Sp. Gr. of Solutions. |
|---|---|---|---|---|---|
| 100 | 3.59 | ... | 65 | 3.40 | 0.9018 |
| 95 | 4.44 | 0.8200 | 60 | 2.80 | 0.9128 |
| 90 | 4.69 | 0.8389 | 50 | 1.87 | 0.9317 |
| 85 | 4.99 | 0.8544 | 40 | 1.13 | 0.9486 |
| 80 | 4.70 | 0.8679 | 25 | 0.56 | 0.9679 |
| 75 | 4.45 | 0.8810 | 15 | 0.38 | 0.9788 |
| 70 | 3.92 | 0.8915 | 0 | 0.24 | 0.9979 |

See remarks under α acetnaphthalide, p. 705

## Solubility of Phenyl Thiourea in Aqueous Solutions of Propyl and of Ethyl Alcohol at 25°.

(Bogdan, 1902–03.)

### In Aq. Propyl Alcohol.

| G. Mols. $C_3H_7OH$ per 1000 Gms. $H_2O$. | Gms. per 1000 Gms. $H_2O$ | |
|---|---|---|
| | $C_3H_7OH$. | $CS(NH_2)NHC_6H_5$. |
| 1.035 | 62.10 | 3.587 |
| 0.5448 | 32.688 | 3.124 |
| 0.1059 | 6.354 | 2.643 |
| 0.05526 | 3.316 | 2.599 |
| 0.04854 | 2.912 | 2.586 |

### In Propyl Alcohol at 0°.

| | | |
|---|---|---|
| 1.000 | 60.06 | 1.21 |
| 0.100 | 6.01 | 1.047 |

### In Aq. Ethyl Alcohol.

| G. Mols. $C_2H_5OH$ per 1000 Gms. $H_2O$. | Gms. per 1000 Gms. $H_2O$ | |
|---|---|---|
| | $C_2H_5OH$. | $CS(NH_2)NHC_6H_5$. |
| 1.1010 | 49.60 | 3.193 |
| 0.5355 | 24.12 | 2.931 |
| 0.1094 | 4.932 | 2.629 |
| 0.05018 | 2.26 | 2.589 |
| 0.03271 | 1.473 | 2.577 |

### Solubility of Phenyl Thiourea in Aqueous Solutions of Acetone, Mannitol, Cane Sugar, Dextrose, and Urea.

(Bogdan, 1902–03.)

| Aqueous Non Electrolyte. | t°. | Gms. per 1000 Gms. $H_2O$ | |
|---|---|---|---|
| | | Non Electrolyte. | $CS(NH_2)NH.C_6H_5$. |
| $(CH_3)_2CO$ | 25 | 7.478 | 2.667 |
| " | " | 2.513 | 2.579 |
| " | " | 1.908 | 2.573 |
| $C_6H_8(OH)_6$ | " | 182.11 | 3.04 |
| " | " | 91.05 | 2.78 |
| $C_{12}H_{22}O_{11}$ | 25 | 338.6 | 3.457 |
| " | " | 170.4 | 3.015 |
| " | " | 34.36 | 2.634 |
| " | " | 18.28 | 2.596 |
| " | " | 10.09 | 2.572 |
| " | 0 | 342.18 | 1.420 |
| " | " | 34.22 | 1.044 |

| Aqueous Non Electrolyte. | t°. | Gms. per 1000 Gms. $H_2O$. | |
|---|---|---|---|
| | | Non Electrolyte. | $CS(NH_2)NHC_6H_5$. |
| $C_6H_{12}O_6$ | 25 | 180 40 | 3.042 |
| " | " | 90.46 | 2.83 |
| " | " | 29.29 | 2.69 |
| " | " | 18.01 | .2.654 |
| " | " | 9.554 | 2.603 |
| $CO(NH_2)_2$ | " | 63.08 | 3.306 |
| " | " | 29.93 | 2.892 |
| " | " | 6.132 | 2.618 |
| " | " | 4.942 | 2.605 |
| " | " | 2.009 | 2.572 |
| " | 0 | 60.11 | 1.310 |
| " | " | 6.01 | 1.048 |

## ANISOLE $C_6H_5OCH_3$.

### Solubility of Anisole in Aqueous Sodium Oleate Solution at 20°.

(Smith, 1932.)

100 gms. 0.4 normal aq. sodium oleate solution (= 10.8 gm. Na oleate per 100 gms. solution) dissolve 2.1 gms. $C_6H_5OCH_3$. When the anisole and oleic acid are mixed and the calculated amount of NaOH to neutralize the acid is added, and the mixture diluted with water to 0.4 normality, the solubility of the anisole is 7.2 gms. $C_6H_5OCH_3$ per 100 gms. sat. solution.

### Reciprocal Solubility of Anisole and Glycerol.

(Mc Ewen, 1923.)

| t°. of solution. | Gms. $C_6H_5OCH_3$ per 100 gms. sat. sol. | t°. of solution. | Gms. $C_6H_5OCH_3$ per 100 gms. sat. sol. |
|---|---|---|---|
| 161.5 | 6.07 | 275.5 | 53.41 |
| 185.3 | 11 29 | 273.5 | 69.46 |
| 250.5 | 27.63 | 263.5 | 78.80 |
| 274.5 | 44.02 | 230.5 | 90.12 |

### Reciprocal Solubility of Anisole and Benzyl Chloride Determined by the Freezing-point Method.

(Wroczynski and Guye, 1910.)

| t° of Melting. | Gms. $C_6H_5OCH_3$ per 100 Gms. Mixture. | Solid Phase. | t° of Melting. | Gms. $C_6H_5OCH_3$ per 100 Gms. Mixture. | Solid Phase. |
|---|---|---|---|---|---|
| −37.2 | 100 | $C_6H_5OCH_3$ | −72.8 Eutec. | 46.1 | $C_6H_5OCH_3+C_6H_5CH_2Cl$ |
| −40 | 93.3 | " | −60 | 28 | $C_6H_5CH_2Cl$ |
| −50 | 75.3 | " | −50 | 13 | " |
| −60 | 62.1 | " | −41.1 | 0 | " |

## BENZYL ALCOHOL $C_6H_5CH_2OH$

100 gms. $H_2O$ dissolve 3.8 gms. $C_6H_5CH_2OH$ at 20°.

100 gms. aq. 0.4 normal sodium oleate solution (= 10.8 gm. Na oleate per 100 gms. solution dissolve 19.0 gms. $C_6H_5CH_2OH$ at 20°. (Smith, 1932.)

**CRESOLS** $C_6H_4(OH)CH_3$ *o*, *m* and *p*.

SOLUBILITY OF EACH SEPARATELY IN WATER.
(At 20°, Vaubel, 1895; Sidgwick, Spurrell and Davies, 1915.)

Determinations by synthetic method; melting-point of *o* = 29.9°, of *m* = 4°, of *p* = 33.8°. Triple point for *o* = 87 and 2.5 gms. per 100 gms. sat. sol. at 8°; triple point for *p* = 86 and 2 gms. per 100 gms. sat. sol. at 8.7°.

| t°. | Gms. per 100 Gms. Sat. Solution. | | | t°. | Gms. per 100 Gms. Sat. Solution. | | |
|---|---|---|---|---|---|---|---|
| | *o* Cresol. | *m* Cresol. | *p* Cresol. | | *o* Cresol. | *m* Cresol. | *p* Cresol. |
| 20 | 2.45 | 2.18 | 1.94 | 120 | 6.22 | 7 | 6.58 |
| 40 | 3.08 | 2.51 | 2.26 | 130 | 6.70 | 8.86 | 9 |
| 50 | 3.22 | 2.72 | 2.43 | 140 | 7.67 | 12.3 | 15.9 |
| 60 | 3.40 | 2.98 | 2.69 | 143.5 crit. t. | ... | ... | ∞ |
| 70 | 3.74 | 3.35 | 3.03 | 147 crit. t. | ... | ∞ | |
| 80 | 4.22 | 3.80 | 3.52 | 150 | 11.1 | | |
| 90 | 4.80 | 4.43 | 4.16 | 160 | 23.7 | | |
| 100 | 5.30 | 5.47 | 5.10 | 162.8 crit. t. | ∞ | | |
| 110 | 5.80 | 5.96 | 5.50 | | | | |

100 gms. sat. solution of Meta cresol in water contain 2.38 gms. at 20°. (Traubmann, 1931; Lipetz and Rimskaja, 1931.)

RECIPROCAL SOLUBILITY OF o, m AND p CRESOLS AND WATER.
(Michels and ten Haaf, 1927.)

The determinations were made by the synthetic method. The m. pt. of the m cresol was 10.6° instead of 4° as previously found.

Results for:

Ortho cresol + water

| t° | Gms. o $(OH)C_6H_4CH_3$ per 100 gms. sat. sol. |
|---|---|
| < 0 | 1.3 |
| 46.2 | 2.9 |
| 86.7 | 4.0 |
| 104.5 | 4.5 |
| 121.0 | 6.9 |
| 134. | 8.7 |
| 157.9 | 17.5 |
| 167.3 | 36.4 |
| 168.9(Crit.t) | 41.0 |
| 168.3 | 45.9 |
| 163.7 | 56.5 |
| 160.1 | 64.7 |
| 139.2 | 74.8 |
| 92.8 | 82.9 |
| 50.5 | 86.2 |

Meta cresol + water

| t° | Gms. m $(OH)C_6H_4CH_3$ per 100 gms. sat. sol. |
|---|---|
| 50.8 | 2.7 |
| 78.7 | 3.6 |
| 92.2 | 4.5 |
| 121.7 | 10.8 |
| 140.4 | 14.0 |
| 147.5 | 23.2 |
| 148.7 | 29.7 |
| 148.8(Crit.t) | 38.0 |
| 148.6 | 48.9 |
| 141.9 | 59.3 |
| 133.2 | 65.9 |
| 120 | 73.1 |
| 90.2 | 79.7 |
| 82.6 | 80.7 |
| 36.2 | 85.9 |

Para cresol + water

| t° | Gms. p $(OH)C_6H_4CH_3$ per 100 gms. sat. sol. |
|---|---|
| 29.5 | 2.21 |
| 82.1 | 3.74 |
| 105.0 | 5.4 |
| 118.5 | 6.9 |
| 127.9 | 9.2 |
| 138.0 | 16.4 |
| 142.5 | 32.3 |
| 142.6(Crit.t) | 36.0 |
| 140.7 | 43.7 |
| 139.5 | 50.2 |
| 136.6 | 56.9 |
| 124.4 | 66.6 |
| 110.8 | 71.3 |
| 59.5 | 81.3 |
| 37.1 | 83.7 |

RECIPROCAL SOLUBILITY OF ORTHO CRESOL AND WATER.
(v. Szelenyi, 1929.)

| t° | Gms. o $OHC_6H_4CH_3$ per 100 gms. sat. sol. |
|---|---|
| 106.4 | 4.90 |
| 141.75 | 7.70 |
| 155.35 | 10.93 |
| 164.6 | 19.81 |
| 168.9 | 29.65 |
| 169.25 | 35.51 |
| 169.7(Crit.t) | 39.50 |
| 169.15 | 48.58 |
| 164.85 | 60.33 |
| 152.3 | 67.70 |
| 130.25 | 75.45 |

## Solubility of Meta Cresol in Aqueous Solutions of Acids and of Salts at 25°.

(Carter and Hardy, 1928.)

In aqueous solutions of:

### Acids

| Gm. Equiv. per 1000 gm. mols. $H_2O$ | | Gms. per 100 gms. sat. solution | |
|---|---|---|---|
| Acid | $OHC_6H_4CH_3$ | Acid | $OHC_6H_4CH_3$ |
| 0.0 (=$H_2O$) | 3.87 | 0.0 | 2.27 |
| 9.62 HCl | 3.39 | 1.87 | 1.96 |
| 20.22 " | 3.17 | 3.86 | 1.79 |
| 40.83 " | 2.83 | 7.52 | 1.54 |
| 49.09 " | 2.80 | 8.90 | 1.50 |
| 66.40 " | 2.71 | 11.72 | 1.42 |
| 77.00 " | 2.67 | 13.30 | 1.37 |
| 8.60 $H_2SO_4$ | 3.39 | 4.39 | 1.91 |
| 18.11 " | 3.09 | 17.24 | 1.26 |
| 38.84 " | 2.57 | 21.94 | 1.08 |
| 52.35 " | 2.34 | 24.96 | 0.95 |
| 61.86 " | 2.14 | 30.98 | 0.76 |
| 83.37 " | 1.86 | | |

### Sodium Salts

| Gm. Equiv. per 1000 gm. mols. $H_2O$ | | Gms. per 100 gms. sat. solution | |
|---|---|---|---|
| Salt | $OHC_6H_4CH_3$ | Salt | $OHC_6H_4CH_3$ |
| 8.20 NaCl | 3.03 | 2.55 NaCl | 1.74 |
| 15.89 " | 2.54 | 4.83 " | 1.43 |
| 27.09 " | 1.89 | 8.00 " | 1.03 |
| 42.19 " | 1.38 | 11.95 " | 0.72 |
| 45.84 " | 1.25 | 12.86 " | 0.65 |
| 54.38 " | 1.04 | 14.92 " | 0.53 |
| 68.26 " | 0.73 | 18.07 " | 0.36 |
| 89.80 " | 0.50 | 22.51 " | 0.23 |
| 6.08 $Na_2SO_4$ | 3.08 | 4.50 $Na_2SO_4$ | 1.73 |
| 14.22 " | 2.39 | 9.96 " | 1.27 |
| 16.29 " | 2.24 | 11.25 " | 1.18 |
| 32.43 " | 1.36 | 20.23 " | 0.65 |
| 41.88 " | 0.97 | 24.72 " | 0.44 |
| 62.33 " | 0.52 | 32.81 " | 0.21 |

### Magnesium Salts

| Gm. Equiv per 1000 gm. mols. $H_2O$ | | Gms. per 100 gms. sat. sol. | |
|---|---|---|---|
| $MgCl_4$ | $OHC_6H_4CH_3$ | $MgCl_4$ | $OHC_6H_4CH_3$ |
| 12.77 | 2.87 | 6.22 | 1.59 |
| 26.87 | 2.19 | 12.30 | 1114 |
| 42.65 | 1.59 | 18.26 | 0.77 |
| 55.49 | 1.28 | 22.55 | 0.59 |
| 61.95 | 1.11 | 24.55 | 0.50 |
| 66.59 | 1.04 | 25.92 | 0.46 |

| Gm. Equiv. per 1000 gm. mols. $H_2O$ | | Gms. per 100 gms. sat. sol. | |
|---|---|---|---|
| $MgSO_4$ | $OHC_6H_4CH_3$ | $MgSO_4$ | $OHC_6H_4CH_3$ |
| 6.86 | 3.13 | 4.31 | 1.76 |
| 14.22 | 2.58 | 8.56 | 1.39 |
| 24.23 | 1.97 | 13.79 | 1.01 |
| 29.97 | 1.69 | 16.55 | 0.84 |
| 47.74 | 1.00 | 24.08 | 0.45 |
| 80.44 | 0.37 | 34.91 | 0.14 |

A few determinations are also given of the solubility of meta cresol in aqueous solutions of phosphoric acid-sodium phosphate mixtures.

Data for equilibrium in the systems o, m and p cresols, Sodium Oleate and Water by Bailey, 1923, are given on p. 1188 of Vol. I, of this compilation.

100 gms. 0.4 normal aqueous sodium oleate solution (= 10.8 gm. Na oleate per 100 gms. solution) dissolve 37.6 gm. ortho cresol at 20°. (Smith, 1932.)

## Equilibrium in the System Ortho Cresol, Methyl Alcohol and Water.

(Szelenyi, 1929.)

The determinations were made by the synthetic method. The results were plotted and the following values obtained for the iso thermal curves.

| Gms. per 100 gms. homogeneous mixture | | |
|---|---|---|
| $OHC_6H_4CH_3$ | $CH_3OH$ | $H_2O$ |
| **Results at 45°** | | |
| 5.5 | 14.46 | 80.04 |
| 6.75 | 17.36 | 76.90 |
| 25.0 | 20.0 | 55.0 |
| 40.0 | 20.07 | 39.93 |
| 73.5 | 8.86 | 17.64 |
| 78.5 | 5.89 | 15.61 |
| **Results at 55°** | | |
| 6.5 | 14.3 | 79.2 |
| 9.75 | 16.8 | 73.45 |
| 31.3 | 18.80 | 49.86 |
| 46.7 | 17.96 | 35.34 |
| 68.5 | 10.54 | 20.96 |
| 77.5 | 6.17 | 16.33 |
| **Results at 70°** | | |
| 5.08 | 10.92 | 84.00 |
| 9.8 | 13.8 | 76.4 |
| 15.8 | 15.64 | 68.56 |
| 40.8 | 16.23 | 42.97 |
| 74.0 | 7.13 | 18.87 |
| 81.2 | 3.49 | 15.31 |
| 82.2 | 2.72 | 15.08 |
| 85.0 | 0.66 | 14.34 |
| **Results at 85°** | | |
| 4.0 | 4.22 | 91.78 |
| 8.9 | 10.5 | 80.6 |
| 15.00 | 13.0 | 72.0 |
| 25.0 | 13.94 | 61.06 |
| 51.0 | 13.49 | 35.51 |
| 66.2 | 9.22 | 24.53 |

| Gms. per 100 gms. homogeneous mixture | | |
|---|---|---|
| $OHC_6H_4CH_3$ | $CH_3OH$ | $H_2O$ |
| **Results at 85° (Con.)** | | |
| 77.2 | 5.34 | 17.46 |
| 78.0 | 3.36 | 18.64 |
| 82.5 | 0.77 | 16.73 |
| 83.5 | 0.14 | 16.36 |
| **Results at 95°** | | |
| 5.0 | 4.62 | 90.38 |
| 11.5 | 10.20 | 78.30 |
| 20.0 | 12.23 | 67.77 |
| 34.2 | 13.26 | 52.54 |
| 73.3 | 4.96 | 21.74 |
| 75.02 | 3.82 | 21.16 |
| 82.5 | 2.13 | 16.37 |
| 81.06 | 0.46 | 17.94 |
| **Results at 110°** | | |
| 5.0 | 0.0 | 95.0 |
| 7.0 | 4.07 | 88.93 |
| 17.8 | 9.47 | 72.73 |
| 34.2 | 10.07 | 55.73 |
| 64.2 | 6.16 | 29.60 |
| 70.8 | 4.47 | 24.73 |
| 76.4 | 2.74 | 20.86 |
| 79.0 | 0.92 | 20.08 |
| 50.2 | 9.26 | 40.54 |
| **Results at 120°** | | |
| 5.5 | 0.0 | 94.5 |
| 8.9 | 3.95 | 87.15 |
| 28.2 | 8.27 | 63.53 |
| 48.0 | 7.96 | 44.04 |
| 65.0 | 5.35 | 25.66 |

| Gms. per 100 gms. homogeneous mixture | | |
|---|---|---|
| $OHC_6H_4CH_3$ | $CH_3OH$ | $H_2O$ |
| **(Results at 120° (Con.)** | | |
| 71.0 | 3.34 | 25.66 |
| 76.8 | 1.02 | 22.18 |
| **Results at 130°** | | |
| 6.1 | 0.0 | 93.9 |
| 9.0 | 2.27 | 88.73 |
| 12.6 | 3.82 | 83.58 |
| 42.6 | 6.6 | 50.80 |
| 68.0 | 3.69 | 28.31 |
| 75.5 | 0.0 | 24.5 |
| **Results at 140°** | | |
| 7.3 | 0.0 | 92.7 |
| 13.0 | 1.09 | 85.91 |
| 17.0 | 3.63 | 79.37 |
| 68.0 | 1.04 | 30.96 |
| 69.0 | 0.39 | 30.61 |
| 72.0 | 0.0 | 28.0 |
| **Results at 150°** | | |
| 9.35 | 0.0 | 90.65 |
| 15.3 | 1.06 | 83.64 |
| 18.7 | 2.07 | 79.23 |
| 63.0 | 0.92 | 36.08 |
| 65.0 | 0.49 | 34.51 |
| 68.5 | 0.0 | 31.5 |
| **Results at 160°** | | |
| 19.5 | 0.0 | 80.5 |
| 24.5 | 0.94 | 74.56 |
| 54.0 | 0.53 | 45.47 |
| 58.5 | 0.0 | 41.5 |

## Distribution of Cresol between Water and Ether. (Vaubel, 1903.)

| Composition of Solvent. | Gms. Cresol in $H_2O$ Layer. | In Ether Layer. |
|---|---|---|
| 200 cc. $H_2O$ + 100 cc. Ether | 0.0570 | 1.0760 |
| 200 cc. $H_2O$ + 200 cc. Ether | 0.0190 | 1.1144 |

One liter aqueous 1 normal solution of the sodium salt of *o* cresol dissolves 7.57 gms. *o* cresol at 25°, 8.32 gms. at 40°, 9.84 gms. at 60° and 13.62 gms. at 80°
(Sidgwick, 1910.)

MISCIBILITY OF AQUEOUS ALKALINE SOLUTIONS OF *m* CRESOL WITH SEVERAL ORGANIC COMPOUNDS INSOLUBLE IN WATER.
(Scheuble, 1907.)

To 5 cc. portions of aq. KOH solution (250 gms. per liter) were added the given amounts of the aq. insoluble compound from a buret, and then the *m* cresol dropwise, until solution occurred. Temp. not stated.

Composition of Homogeneous Solution.

| cc. Aq. KOH. | Aq. Insol. Cmpd. | *m* Cresol. |
|---|---|---|
| 5 | 2 cc. (1.64 gms.) Octyl Alcohol* | 1.1 gms. |
| 5 | 5 " (4.1 " ) " " | 1.8 " |
| 5 | 2 " (1.74 " ) Toluene | 4.4 " |
| 5 | 3 " (2.61 " ) " | 5.1 " |
| 5 | 2 " (1.36 " ) Heptane | 6.4 " |

* = the normal secondary alcohol, the so-called capryl alcohol, $CH_3(CH_2)_5CH(OH)CH_3$.

RECIPROCAL SOLUBILITY OF ORTHO CRESOL AND ETHYL ALCOHOL, DETERMINED BY THE FREEZING-POINT METHOD. (Perrakis, 1925.)

| t° of Crystallization. | Mol. per cent *o* $CH_3.C_6H_4.OH$ in sat. sol. | t° of Crystallization. | Mol. per cent *o* $CH_3.C_6H_4.OH$ in sat. sol. |
|---|---|---|---|
| 29.05..... | 100.00 | 1.70..... | 71.10 |
| 22.60..... | 91.31 | — 4.00..... | 65.84 |
| 14.00..... | 83.00 | —17.20..... | 56.39 |
| 8.30..... | 76.89 | —31.00..... | 48.40 |

Freezing-point data for mixtures of o, m and p cresols are given by (4)(5)(7)(10) and (11). Results are given for mixtures of Cresols and:

Aniline(15)(18)
Benzene(8)(17)
Benzoic acid(3)
Benzylamine(22)
Carbamide(23)
Chlor acetic acid(13)(20)
Cineole(1)
Dichloro benzene(8)
Dimethyl aniline(23)
Dimethyl pyrone(13)
Diphenyl amine(25)
Di xylylamines(21)
Ethylene diamine(24)
Naphthalene(26)
Naphthalene diamine(23)
Naphthylamines(25)
Phenol(4)(6)(7)
Picric acid(14)
Piperidine(23)
Pyridine(2)(9)
Quinoline(23)
Styphnic acid(12)
Sulfuric acid(19)
Tri chlor acetic acid(13)
Toluidine(23)
Urea(16)(23)
Xylidines(21)

(1) Bellucci and Grassi, 1913; (2) Bramley, 1916; (3) Da Silva, 1934; (4) Dawson and Mountford, 1918; (5) Deffet, 1938; (6) Fischer and Gröppel, 1917; (7) Fox and Barker, 1918; (8) Glass and Madgin, 1934; (9) Hatcher and Skirrov, 1917; (10) Hill and Davis, 1926; (11) Hill and Mosbacker, 1925; (12) Jefremow, 1934; (13) Kendall, 1914; (14) Kendall, 1916; (15) Kremann, 1906; (16) Kremann, 1907; (17) Kremann and Borjanovics, 1916; (18) Kremann and Philip, 1903; (19) Kendall and Carpenter, 1914; (20) Mamelli,and Cocconi, 1923; (21) Morgan and Pettet, 1935; (22) Puschin and Rikovski, 1937; (23) Puschin and Sladovic, 1928; (24) Puschin and Sladovic, 1928a; (25) Puschin and Basara, 1927; (26) Rhodes and Hance, 1921

**GUAIACOL** (o) $CH_3OC_6H_4OH$.

The critical solution temperature of mixtures of guaiacol and citronellal is at about 18°. (Lecat, 1928.)

Freezing-point data are given for mixtures of guaiacol and:

| | | |
|---|---|---|
| Aniline(13) | Ethylene diamine(14) | Phenylene diamine(4) |
| Benzene(9)(11) | Ethyl urethan(5)(13) | Phenyl hydrazine(9)(11) |
| Benzylamine(11) | Melanine acids(1) | Piperidine(11) |
| Chlor acetic acid(7)(10) | Menthol(2)(16) | Pyridine(13) |
| Cineole(3) | Naphthalene(13) | Quinoline(9)(11) |
| Dimethyl aniline(9)(11) | Naphthylamine(8)(13) | Toluidines(13) |
| Diphenyl amine(13) | Picric acid (15) | Urea(12) |

(1) Adler, 1932; (2) Adamanis, 1933; (3) Bellucci and Grassi, 1913; (4) Dezelic, 1932; (5) Gilbert and Clarke, 1927; (6) Hrynakowski and Adamanis, 1933; (7) Mamelli and Coccini, 1923; (8) Puschin and Masarowtsch, 1914; (9) Puschin and Pinter, 1929; (10) Puschin & Rikovski, 1932; (11) Puschin & Rikovski, 1937; (12) Puschin & König, 1928; (13) Puschin and Vaic, 1926; (14) Puschin and Sladovich, 1928a. (15) Philip and Smith, 1915.

**DIMETHYL γ PYRONE** $CO<\begin{matrix}CH=C(CH_3)\\CH=C(CH_3)\end{matrix}>O$

100 gms. Carbon tetrachloride dissolve 1.04 gms. dimethyl pyrone at 20°.
» Chloroform » 34.37 » » » »
(Pawlewski, 1914, 1926.)

Freezing-point data are given for mixtures of dimethyl pyrone and:

| | | |
|---|---|---|
| Acetic acid(2) | Dinitro phenol(2) | Salicylic acid(2) |
| Benzoic acid(1) | Formic acid(1) | Sulfuric acid(3) |
| Chlor acetic acid(2) | Hydro cinnamic acid(1) | Toluic acids(2) |
| Cinnamic acid(1) | Naphthols(1) | Trichlor acetic acid(2)(4) |
| Cresols(1) | Nitro phenols(2) | Trinitro benzene(5) |
| Dichlor acetic acid(1) | Phenol(2) | Trinitro toluene(2) |

(1) Kendall, 1914; (2) Kendall, 1914a; (3) Kendall and Carpenter, 1914; (4) Plotnikow, 1911; (5) Sudborough and Beard, 1911.

**NITRO TOLUIDINE** m $NO_2(CH_3)C_6H_3NH_2$.

Freezing-point data for mixtures of m nitro toluidine and benzene are given by Dessart, 1926.

## THEOBROMINE (3.7 Dimethyl Xanthine) $C_5H_2(CH_3)_2N_4O_2$.

SOLUBILITY IN SEVERAL SOLVENTS.

| Solvent. | t°. | Gms. $C_5H_2(CH_3)_2N_4O_2$ per 100 Gms. Solvent. | Authority. |
|---|---|---|---|
| Water | 18 | 0.0305 | (Paul, 1901.) |
| " | 15–20 | 0.059 | (Squire & Caines, 1905.) |
| Aq. 0.25 *n* HCl | 18 | 0.047 | (Paul, 1901.) |
| " 1 *n* HCl | 18 | 0.083 | " |
| " 0.1 *n* NaOH | 18 | 1.78 | " |
| " 0.25 *n* " | 18 | 4.56 | " |
| " 15.6 per cent $Na_3(PO_4)_2$.Sol. | 15 | 3.69 | (Brissemoret, 1898.) |
| 92.3 Wt. % Alcohol | 21 | 0.045 | (Squire & Caines, 1905.) |
| 90 Wt. % Alcohol | 15–20 | 0.02 | " |
| Dichlorethylene | 15 | 0.005 | (Wester & Bruins, 1914.) |
| Trichlorethylene | 15 | 0.008 | " |
| Carbon Tetrachloride | b. pt. | 0.021 | (Göckel, 1897.) |
| Ether | b. pt. | 0.032 | " |

SOLUBILITY OF THEOBROMINE IN SEVERAL SOLVENTS. (Wadsworth, 1920.)

The method of obtaining saturation and analysis of the solutions is not described.

| Solvent. | Gms. Theobromine per 100 cc. sat. sol. at 15°.5. | Gms. Theobromine per 100 cc. sat. sol. at b. pt. |
|---|---|---|
| Water | 0.060 | 0.700 |
| Aq. 90 % ethyl alcohol. | – | 0.390 |
| Absolute » » | – | 0.100 |
| Acetylene tetrachloride. | 0.090 | 0.870 |
| Aniline | 0.650 | 8.000 |
| Benzene | 0.005 | 0.010 |
| Carbon tetrachloride | 0.020 | 0.040 |
| Chloroform | 0.060 | 0.070 |
| Ethyl ether | 0.003 | 0.003 |
| Trichlor ethylene | 0.020 | 0.030 |

100 gms. amyl alcohol dissolve 0.02 gm. theobromine at 15°. (Debourdeaux, 1917.)

DISTRIBUTION OF THEOBROMINE BETWEEN : (Aiello, 1921.)

Water and Olive Oil.

| t°. | Gms. Theobromine per 100 cc. Aq. layer (*a*). | Oil layer (*o*). | $\frac{o}{a}$. |
|---|---|---|---|
| 16 | 0.041 | 0.059 | 1.45 |
| 17 | 0.037 | 0.063 | 1.70 |

Horse Serum and Olive Oil.

| t°. | Gms. Theobromine per 100 cc. Serum layer (*s*). | Oil layer (*o*). | $\frac{o}{s}$. |
|---|---|---|---|
| 20 | 0.153 | 0.057 | 0.37 |
| 20 | 0.153 | 0.067 | 0.43 |

## THEOPHYLLINE (1.3 Dimethyl Xanthine) $C_5H_2(CH_3)_2N_4O_2$.

100 gms. $H_2O$ dissolve 0.52 gm. theophylline at 15–20°. (Squire & Caines, 1905.)
100 cc. 90 vol. % alcohol dissolve 1.25 gms. theophylline at 15–20°. " "

DISTRIBUTION OF THEOPHYLLINE BETWEEN : (Aiello, 1921.)

Water and Olive Oil.

| t°. | Gms. Theophylline per 100 cc. Aq. layer (*a*). | Oil layer (*o*). | $\frac{o}{a}$. |
|---|---|---|---|
| 18 | 0.200 | 0.300 | 1.50 |
| 18 | 0.363 | 0.637 | 1.75 |

Horse Serum and Olive Oil.

| t°. | Gms. Theophylline per 100 cc. Serum layer (*s*). | Oil layer (*o*). | $\frac{o}{s}$. |
|---|---|---|---|
| 19 | 0.054 | 0.057 | 0.94 |
| 20 | 0.065 | 0.044 | 0.67 |

## TOLUENE SULFONIC ACIDS o and p $CH_3C_6H_4SO_3H$.

SOLUBILITY OF O AND P TOLUENE SULFONIC ACIDS, EACH SEPARATELY, IN AQUEOUS SULFURIC ACID AT 18°.
(Weibel, 1930.)

| Wt.% $H_2SO_4$ in aq. solvent | Gms. per 100 gms. sat. sol. o $CH_3C_6H_4SO_3H$ | p $CH_3C_6H_4SO_3H$ | Wt.% $H_2SO_4$ in aq. solvent | Gms. per 100 gms. sat. sol. o $CH_3C_6H_4SO_3H$ | p $C_6H_3C_6H_4SO_3H$ |
|---|---|---|---|---|---|
| 35 | 19.2 | 17.5 | 60 | 0.45 | 6.9 |
| 40 | 9.9 | 10.1 | 65 | 0.46 | 8.6 |
| 45 | 4.6 | 4.8 | 75 | 0.5 | 11.8 |
| 50 | 2.4 | 5.3 | 85 | 4.7 | — |
| 55 | 1.3 | 5.1 | | | |

**GUANIDINE PICRATE** $HN:C(NH_2)_2.OHC_6H_2(NO_2)_3$.

100 gms. sat. solution in water contain 0.035 gm. picrate at 7°.5, 0.061 gm. at 21°, 0.09 gm. at 32°.5, 0.167 gm. at 48°, 0.502 gm. at 78° and 0.864 gm. at 92°.

100 gms. sat. solution in aq. 50% ethyl alcohol contain 0.12 gm. at 8°, 0.191 gm. at 19°, 0.397 gm. at 37°, 0.883 gm. at 57° and 1.662 gm. at 74°. (Medes 1925, 1926.)

100 cc. $H_2O$ dissolve 0.132 gm. **methyl guanidine picrate** at 10° and 0.178 gm. at 20°.
" 0.117 " **dimethyl guanidine picrate** " 0.162 "
" 0.697 " **ammonium picrate** " 1.03 "
(Greenwald, 1926.

2.4 Dimethyl **PYRIDINE** $C_5H_3(CH_3)_2N$.

RECIPROCAL SOLUBILITY OF 2.4 DIMETHYL PYRIDINE AND WATER.
(Jones and Speakman, 1921.)

The determinations were made by the Alexejeff synthetic method.

| t° of lower solution point. | Wt. per cent $H_2O$. in mixture. | t° of lower solution point. | Wt. per cent $H_2O$ in mixture. |
|---|---|---|---|
| >150..... | 15.99 | 27.2..... | 55.11 |
| >150..... | 23.14 | 23.0..... | 67.96 |
| 68.5..... | 30.92 | 23.0..... | 79.57 |
| 53.0..... | 37.50 | 35.0..... | 93.00 |
| 39.0..... | 45.14 | 54.3..... | 95.06 |

The minimum critical solution temperature is 22.5°.

Phenyl **METHYL AMINE HYDROCHLORIDE** $(CH_3)(C_6H_5)NH.HCl$.

100 gms. $H_2O$ dissolve 378.8 gms. $(CH_3)(C_6H_5)NH.HCl$ at 25°. (Peddle and Turner, '13.)

METHYL ANILINE $C_6H_5NHCH_3$.

RECIPROCAL SOLUBILITY OF METHYL ANILINE AND GLYCEROL.
(Parvatiker and McEwen, 1924.)

| t° | Gms. $C_6H_5NHCH_3$ per 100 gms. sat. sol. | t° | Gms. $C_6H_5NHCH_3$ per 100 gms. sat. sol. |
|---|---|---|---|
| 197.5 | 89.5 | 223.5 | 51.66 |
| 220.0 | 73.5 | 222.5 | 40.60 |
| 223.0 | 66.42 | 219.0 | 30.26 |
| 224.5 | 59.48 | 190.5 | 14.60 |

CRITICAL SOLUTION TEMPERATURES OF MIXTURES OF METHYL ANILINE AND OTHER SOLVENTS.
(Thiry, 1925.)

| Solvent | f. pt. of solvent | b. pt. of solvent | Critical solution temp. with methyl aniline | Gms. $C_6H_5NHCH_3$ per 100 gms. homogeneous mixture |
|---|---|---|---|---|
| Ethyl cyclopentane | -137.9 | 103.0 | -49.4 | 24.0 |
| Propyl " " " | -120.3 | 131.4 | -43.0 | 22.5 |
| Methyl " " | -141.0 | 71.9 | -47.4 | 22.5 |
| Hexane | - 94.65 | 69.0 | -18.6 | 27.5 |
| Methyl 3 pentane | — | 63.2 | -17.25 | 26.0 |
| Iso hexane | -137.1 | 60.18 | -14.0 | 27.0 |
| Tri methyl ethyl methane | -98.2 | 19.7 | - 7.65 | 27.5 |

Freezing-point data for mixtures of methyl aniline and benzyl chloride are given by Wroczynski and Guye, 1910.

## BENZYL AMINE $C_6H_5CH_2.NH_2$.

DISTRIBUTION OF BENZYLAMINE AT 25° BETWEEN: (Smith, 1921-1922.)

| Water and Chloroform. Millimols. $C_6H_5CH_2NH_2$ per liter of | | | Water and Ethyl Ether. Millimols. $C_6H_5CH_2.NH_2$ per liter of | | | Water and Xylene. Millimols. $C_6H_5CH_3.NH_2$ per liter of | | |
|---|---|---|---|---|---|---|---|---|
| $H_2O$ layer ($C_1$). | $CHCl_3$ layer ($C_2$). | $\frac{C_2}{C_1}$. | $H_2O$ layer ($C_1$). | $(C_2H_5)_2O$ layer ($C_2$). | $\frac{C_2}{C_1}$. | $H_2O$ layer ($C_1$). | $C_6H_4(CH_3)_2$ layer ($C_2$). | $\frac{C_2}{C_1}$. |
| 0.30 | 3.85 | 12.9 | 0.675 | 1.335 | 1.97 | 0.81 | 1.19 | 1.47 |
| 0.65 | 9.55 | 14.7 | 1.10 | 3.25 | 2.04 | 1.58 | 2.42 | 1.53 |
| 1.20 | 19.6 | 16.3 | 1.85 | 3.725 | 2.01 | 3.35 | 6.65 | 1.99 |
| | | | 2.85 | 6.05 | 2.12 | 6.32 | 13.68 | 2.16 |
| | | | 4.55 | 9.60 | 2.10 | | | |

The coefficient of distribution at 25° of benzylamine between water and benzene at concentrations varying from 0.0162 to 0.0168 gm. mols. per liter in the aqueous phase is 4.03

The coefficient of distribution between water and heptane at a concentration of 0.0383 gm. mols. per liter of the aqueous phase is 0.614. (Williams and Soper, 1930.)

F. pt. data for mixtures of benzylamine with cresol, phenol, chlor phenol and with guaiacol are given by Puschin and Rikovski, 1937.

## BENZYLAMINE HYDROCHLORIDE $C_6H_5CH_2.NH_2.HCl$.

100 gms. $H_2O$ dissolve 50.6 gms. of the compound at 25°. (Peddle and Turner, 1913.)

## DiBENZYLAMINE HYDROCHLORIDE $(C_6H_5CH_2)_2NH.HCl$.

100 gms. $H_2O$ dissolve 2.17 gms. of the compound at 25°. (Peddle and Turner, 1913.)
100 gms. chloroform dissolve 0.37 gm. of the compound at 25°. " "

## TriBENZYLAMINE HYDROCHLORIDE $(C_6H_5CH_2)_3N.HCl$.

100 gms. $H_2O$ dissolve 0.61 gm. of the compound at 25°. (Peddle and Turner, 1913.)
100 gms. chloroform dissolve 11.41 gms. of the compound at 25°. " "

## TOLUIDINES $C_6H_4.CH_3.NH_2$, *o*, *m* and *p*.

SOLUBILITY IN WATER.
(Vaubel, 1895; Lowenherz, 1898.)

| t°. | Gms. $C_6H_4CH_3.NH_2$ per 1000 Gms. $H_2O$. | Solid Phase. | t°. | Gms. $C_6H_4CH_3NH_2$ per 1000 Gms. $H_2O$. | Solid Phase. |
|---|---|---|---|---|---|
| 20 | 16.26 | Liquid ortho T. | 20.8 | 7.39 | Para T |
| 20 | 0.15 | Ortho T. | 26.7 | 9.50 | " |
| 20 | 6.54 | Para T. | 31.7 | 11.42 | " |

One liter sat. solution in water contains 15 gms. *o* toluidine at 25°.
One liter sat. solution in 1 *n* aq. *o* toluidine hydrochloride, contains 30 gms. *o* toluidine at 25°. (Sidgwick, 1910.)

The following results for *p* toluidine, differing considerably from the above, are given by Walker (1890).

| t°. | 22° | 30° | 36.7° | 44° | 57.5° | 69° |
|---|---|---|---|---|---|---|
| Gms. *p* Toluidine per 100 Gms. Sat. Sol. in Water | 19.6 | 26.9 | 35.4 | 44.5 | 51.4 | 58.9 |

## Reciprocal Solubility of Ortho Toluidine and Water.

(Angelescu, 1925.)

The temperatures of clouding of mixtures of weighed amounts of the two constituents, contained in sealed tubes, were carefully determined.

| t. | Gms. $C_6H_4CH_3.NH_2$ (*o*) per 100 gms. Aqueous layer. | Gms. $C_6H_4CH_3.NH_2$ (*o*) per 100 gms. Toluidine layer. |
|---|---|---|
| 0..... | 1.68 | 97.65 |
| 20..... | 1.69 | 97.50 |
| 122..... | – | 93.13 |
| 150..... | 5.65 | – |
| 163..... | – | 88.46 |
| 181..... | – | 85.33 |
| 185..... | 12.46 | – |

| t°. | Gms. $C_6H_4CH_3.NH_2$ (*o*) per 100 gms. Aqueous layer. | Toluidine layer. |
|---|---|---|
| 198..... | 16.47 | – |
| 200..... | – | 79.77 |
| 207..... | – | 74.70 |
| 212..... | – | 66.80 |
| 215..... | – | 56.08 |
| 216 crit. t. | 50.09 | |

## Solubility of Ortho Toluidine in Aqueous Solutions of Acetic Acid.

(Angelescu, 1925.)

The determinations were made by adding ortho toluidine drop by drop to water or aqueous acetic acid just to the appearance of clouding at a definite temperature. The quantities of the three constituents were determined by careful weighings.

Results at 0°.

| Gms. per 100 gms. sat. sol. $C_6H_4CH_3NH_2$ (*o*). | Gms. per 100 gms. sat. sol. $CH_3COOH$. |
|---|---|
| 1.68 | 0.00 |
| 2.36 | 0.56 |
| 4.16 | 2.05 |
| 5.13 | 3.51 |
| 6.15 | 5.37 |
| 7.41 | 7.10 |
| 9.09 | 9.76 |
| 11.23 | 12.50 |
| 13.63 | 14.54 |
| 17.79 | 16.72 |
| 22.02 | 17.94 |
| 27.29 | 18.79 |
| 32.13 | 19.17 |
| 35.29 | 19.39 |
| 38.54 | 19.42 |
| 41.26 | 19.48 |
| 45.58 | 19.46 |
| 50.99 | 19.33 |
| 57.44 | 18.71 |
| 64.74 | 17.31 |
| 70.54 | 15.56 |
| 75.19 | 13.80 |
| 80.74 | 11.28 |
| 85.06 | 8.85 |
| 89.27 | 6.22 |
| 94.21 | 2.75 |
| 97.65 | 0.00 |

Results at 20°.

| Gms. per 100 gms. sat. sol. $C_6H_4CH_3NH_2$ (*o*). | Gms. per 100 gms. sat. sol. $CH_3COOH$. |
|---|---|
| 1.69 | 0.00 |
| 2.79 | 1.19 |
| 3.72 | 2.47 |
| 4.37 | 3.63 |
| 5.14 | 5.17 |
| 5.86 | 6.50 |
| 6.84 | 8.25 |
| 7.66 | 9.86 |
| 8.60 | 11.34 |
| 9.49 | 12.75 |
| 10.35 | 14.02 |
| 11.62 | 15.26 |
| 12.81 | 16.33 |
| 15.02 | 17.80 |
| 17.66 | 18.97 |
| 20.33 | 19.85 |
| 23.21 | 20.51 |
| 27.67 | 21.13 |
| 31.19 | 21.36 |
| 34.33 | 21.77 |
| 38.22 | 21.44 |
| 39.89 | 21.41 |
| 46.93 | 21.27 |
| 50.12 | 21.03 |
| 57.59 | 19.99 |
| 65.51 | 18.00 |
| 73.92 | 14.79 |
| 82.11 | 10.57 |
| 89.36 | 6.03 |
| 93.55 | 2.96 |
| 97.50 | 0.00 |

## Solubility of Ortho Toluidine in Aqueous Solutions of Propionic Acid.

(Angelescu, 1928.)

Results at 0°

| Gms. per 100 gms. sat. solution o $CH_3C_6H_4NH_2$ | Gms. per 100 gms. sat. solution $C_2H_5COOH$ |
|---|---|
| 1.68 | 0.0 |
| 3.26 | 1.71 |
| 5.69 | 6.50 |
| 8.15 | 13.40 |
| 10.30 | 18.67 |
| 15.03 | 23.07 |
| 20.01 | 27.01 |
| 25.74 | 30.70 |
| 29.29 | 32.63 |
| 32.44 | 33.78 |
| 37.76 | 34.65 |
| 41.01 | 34.42 |
| 48.56 | 32.37 |
| 57.30 | 28.38 |
| 66.22 | 23.23 |
| 75.93 | 16.87 |
| 89.64 | 6.45 |
| 97.65 | 0.0 |

Results at 20°

| Gms. per 100 gms. sat. solution o $CH_3C_6H_4NH_2$ | Gms. per 100 gms. sat. solution $C_2H_5COOH$ |
|---|---|
| 1.69 | 0.0 |
| 4.28 | 5.80 |
| 6.50 | 12.18 |
| 8.56 | 16.59 |
| 10.52 | 19.36 |
| 15.54 | 24.09 |
| 20.36 | 27.27 |
| 25.06 | 29.21 |
| 30.42 | 32.38 |
| 33.45 | 33.31 |
| 38.59 | 33.81 |
| 45.59 | 32.74 |
| 54.38 | 29.51 |
| 63.25 | 24.87 |
| 72.52 | 19.17 |
| 81.92 | 12.34 |
| 93.35 | 3.39 |
| 97.50 | 0.0 |

## Distribution of Acetic Acid at 20° Between Water and Ortho Toluidine.

(Angelescu, 1925.)

In connection with the results showing the solubility of ortho toluidine in aqueous solutions of acetic acid, a series of determinations of the distribution of acetic acid between water and toluidine was needed in order to ascertain the composition of those solutions in contact with each other at a given temperature. The results which were obtained are as follows.

| Gms. $CH_3COOH$ per 100 gms. | | $\frac{C_1}{C_2}$. | Gms. $CH_3COOH$ per 100 gms. | | $\frac{C_1}{C_2}$. |
|---|---|---|---|---|---|
| $H_2O$ layer ($C_1$). | Toluidine layer ($C_2$). | | $H_2O$ layer ($C_1$). | Toluidine layer ($C_2$). | |
| 1.45 | 0.71 | 2.04 | 13.94 | 11.05 | 1.26 |
| 2.87 | 1.55 | 1.85 | 15.49 | 12.62 | 1.23 |
| 3.77 | 2.14 | 1.76 | 16.39 | 13.78 | 1.18 |
| 7.22 | 4.65 | 1.55 | 17.64 | 15.71 | 1.12 |
| 7.97 | 5.19 | 1.53 | 18.87 | 17.18 | 1.09 |
| 11.37 | 8.12 | 1.40 | 19.41 | 18.06 | 1.07 |

Angelesco, 1925, next determined the temperatures at which two layers are formed in solutions containing constant concentrations of acetic acid and variable percentages of water and ortho toluidine. For this purpose mixtures of toluidine and acetic acid and of water and acetic acid, containing in both cases the same weight per cent of acetic acid, were prepared. Variable mixtures of these two solutions yield in every case a ternary mixture containing a constant percentage of acetic acid. On gradually changing the temperature of such ternary mixtures, containing respectively 19.94, 21.84, 23.33 and 23.60 per cent of $CH_3CO\,OH$, an upper and a lower point was found at which clouding occurs. Thus for these ranges of concentration, the systems yield closed curves of solubility having an upper and a lower critical temperature of solution. The following results were obtained.

### Variation of the Temperature of Solution in a Ternary Mixture of Ortho Toluidine containing 19.94 per cent of Acetic Acid.

| Gms. $C_6H_4CH_3NH_2$ per 100 gms. sat. sol. | Lower temp. | Upper temp. | Gms. $C_6H_4CH_3NH_2$ per 100 gms. sat. sol. | Lower temp. | Upper temp. | Gms. $C_6H_4CH_3NH_2$ per 100 gms. sat. sol. | Lower temp. | Upper temp. |
|---|---|---|---|---|---|---|---|---|
| 59.09 | 22.5 | 72.0 | 34.65 | 5.6 | not. det. | 19.38 | 22.4 | not. det. |
| 57.84 | 17.8 | 78.6 | 33.10 | 6.2 | » | 18.86 | 24.0 | » |
| 56.54 | 14.5 | 84.2 | 31.78 | 6.6 | » | 18.41 | 25.6 | » |
| 52.27 | 12.5 | 90.4 | 30.47 | 7.3 | » | 17.89 | 27.5 | » |
| 54.05 | 10.4 | not. det. | 29.35 | 7.9 | » | 17.45 | 29.5 | » |
| 53.13 | 8.8 | » | 28.23 | 8.7 | » | 17.00 | 31.8 | » |
| 52.09 | 7.6 | » | 27.23 | 9.5 | » | 16.62 | 33.6 | » |
| 50.67 | 6.7 | » | 26.26 | 10.4 | » | 16.24 | 35.5 | » |
| 49.43 | 6.0 | » | 25.39 | 11.4 | » | 15.85 | 37.4 | » |
| 47.74 | 5.2 | » | 24.20 | 12.9 | » | 15.40 | 41.2 | » |
| 46.12 | 4.9 | » | 23.47 | 13.8 | » | 15.05 | 43.5 | » |
| 44.53 | 4.6 | » | 22.78 | 15.0 | » | 14.72 | 47.0 | » |
| 42.93 | 4.6 | » | 22.08 | 16.3 | » | 14.36 | 51.0 | 90.0 |
| 41.29 | 4.6 | » | 21.43 | 17.5 | » | 14.17 | 54.0 | 86.5 |
| 39.69 | 4.6 | » | 20.63 | 19.2 | » | 13.97 | 63.0 | 80.5 |
| 37.98 | 4.8 | » | 20.20 | 20.1 | » | 13.68 | 68.0 | 76.0 |
| 36.23 | 5.1 | » | 19.75 | 21.5 | » | | | |

## TOLUIDINES

### Variation of the Temperature of Solution in Ternary Ortho Toluidine Mixtures containing 21.84 per cent of Acetic Acid.

(Angelescu, 1925, Con.)

| Gms. $C_6H_4CH_3NH_2$ per 100 gms. sat. sol. | Lower temp. | Upper temp. | Gms. $C_6H_4CH_3NH_2$ per 100 gms. sat. sol. | Lower temp. | Upper temp. | Gms. $C_6H_4CH_3NH_2$ per 100 gms. sat. sol. | Lower temp. | Upper temp. |
|---|---|---|---|---|---|---|---|---|
| 52.57 | 48.2 | 56.0 | 36.43 | 23.3 | not. det. | 21.21 | 37.0 | not. det. |
| 51.55 | 39.0 | 67.5 | 34.79 | 23.3 | » | 20.48 | 39.0 | » |
| 50.71 | 35.5 | 73.5 | 32.74 | 23.5 | » | 19.80 | 41.6 | » |
| 49.83 | 33.0 | 77.5 | 30.58 | 24.2 | » | 19.07 | 45.5 | » |
| 49.02 | 31.0 | 81.0 | 29.00 | 25.1 | » | 18.54 | 48.5 | » |
| 48.20 | 29.0 | 83.5 | 27.60 | 26.2 | » | 18.06 | 51.4 | 89.7 |
| 47.34 | 28.4 | 86.0 | 26.15 | 27.5 | » | 17.76 | 55.0 | 86.5 |
| 46.27 | 27.4 | 89.0 | 24.88 | 29.3 | » | 17.61 | 57.0 | 84.5 |
| 44.25 | 25.6 | not. det. | 23.76 | 31.1 | » | 17.44 | 59.5 | 82.0 |
| 42.40 | 24.6 | » | 22.84 | 32.8 | » | 17.24 | 63.0 | 78.5 |
| 39.99 | 24.0 | » | 21.99 | 34.7 | » | 17.06 | 67.0 | 74.0 |
| 38.23 | 23.5 | » | | | | | | |

### Variation in the Temperature of Solution in Ternary Ortho Toluidine Mixtures containing : (Angelescu, 1925, Con.)

23.33 per cent $CH_3COOH$.

| Gms. $C_6H_4CH_3NH_2$ per 100 gms. sat. sol. | Lower temp. | Upper temp. |
|---|---|---|
| 39.15 | 52.5 | 71.0 |
| 38.26 | 51.2 | 75.5 |
| 37.15 | 49.6 | 78.5 |
| 36.12 | 48.2 | 81.0 |
| 34.95 | 47.2 | 83.0 |
| 33.73 | 46.3 | 85.8 |
| 32.02 | 45.7 | 87.8 |
| 30.66 | 45.6 | 88.5 |
| 29.47 | 46.0 | 89.3 |
| 28.22 | 47.6 | 89.5 |
| 26.82 | 49.0 | 88.8 |
| 25.25 | 52.2 | 87.2 |
| 23.95 | 56.0 | 84.5 |
| 22.83 | 61.7 | 78.5 |
| 22.32 | 69.0 | 74.0 |

23.6 per cent $CH_3COOH$.

| Gms. $C_6H_4CH_3NH_2$ per 100 gms. sa.. sol. | Lower temp. | Upper temp. |
|---|---|---|
| 37.45 | 57.5 | 69.0 |
| 36.80 | 55.0 | 75.5 |
| 36.11 | 53.5 | 76.0 |
| 35.28 | 51.0 | 78.5 |
| 34.28 | 50.5 | 80.5 |
| 33.34 | 50.0 | 82.5 |
| 32.27 | 49.5 | 84.5 |
| 30.68 | 49.0 | 85.5 |
| 29.69 | 49.5 | 86.0 |
| 28.86 | 50.5 | 85.8 |
| 27.86 | 51.2 | 85.5 |
| 26.60 | 53.4 | 84.8 |
| 25.73 | 55.0 | 83.7 |
| 25.01 | 57.0 | 82.0 |
| 24.63 | 58.5 | 80.7 |
| 24.23 | 61.0 | 79.0 |
| 23.83 | 64.0 | 77.0 |

With a concentration of acetic acid of 24.52 per cent, these is no longer formation of two liquid phases at any temperature.

### Distribution of Para Toluidine Between Water and Carbon Tetrachloride.

(Vaubel, 1903.)

| Gms. *p* Toluidine Used. | Volumes of Solvents. | Gms. $C_6H_4(CH_3)NH_2$ *p* in: | |
|---|---|---|---|
| | | $H_2O$ Layer. | $CCl_4$ Layer. |
| 1 | 200 cc. $H_2O$ + 100 cc. $CCl_4$ | 0.1406 | 0.8594 |
| 1 | 200 cc. $H_2O$ + 200 cc. $CCl_4$ | 0.0666 | 0.9334 |

### Distribution of Propionic Acid Between Water and Ortho Toluidine at 20°.

(Angelescu, 1928.)

These determinations were made in connection with the results showing the solubility of ortho toluidine in aqueous solutions of propionic acid.

| Gms. $C_2H_5COOH$ per 100 gms. $H_2O$ layer(1) | Gms. $C_2H_5COOH$ per 100 gms. o Toluidine layer(2) | $\frac{1}{2}$ | Gms. $C_2H_5COOH$ per 100 gms. $H_2O$ layer(1) | Gms. $C_2H_5COOH$ per 100 gms. o Toluidine layer(2) | $\frac{1}{2}$ |
|---|---|---|---|---|---|
| 0.25 | 0.26 | 0.962 | 8.56 | 17.94 | 0.477 |
| 0.92 | 1.22 | 0.754 | 9.09 | 19.27 | 0.472 |
| 2.15 | 3.49 | 0.616 | 11.36 | 24.84 | 0.457 |
| 3.12 | 5.29 | 0.597 | 12.71 | 27.84 | 0.457 |
| 4.96 | 9.22 | 0.538 | 13.58 | 29.28 | 0.464 |
| 6.03 | 11.40 | 0.525 | 14.45 | 30.52 | 0.473 |
| 8.11 | 16.74 | 0.484 | 17.42 | 33.73 | 0.516 |

The author also determined upper solution temperatures of mixtures containing 30.61, 32.07 and 34.10 percent propionic acid and percentages of o toluidine varying from about 25 to 50 percent.

100 gms. aqueous 0.4 normal sodium oleate solution (= 10.8 gms. Na oleate per 100 gms. solution) dissolve 13.5 gms. para $CH_3C_6H_4NH_2$ at 45°. (Smith, 1932.)

Results for the solubility of p toluidine in saturated aqueous solutions of sodium benzene, sodium xylene and sodium cymene sulfonates at various temperatures are given by Hauslick, 1935.

### Distribution of *o*, *m* and *p* Toluidine between Water and Benzene at 25°.

(Farmer and Warth, 1904.)

| Base. | Dist. Coef. $\frac{\text{Conc. in } C_6H_6}{\text{Conc. in } H_2O}$. |
|---|---|
| *o* Toluidine | 13.4 |
| *m* " | 19.1 |
| *p* " | 24.1 |

### Distribution of Para Toluidine Between:

(Taubmann, 1932.)

Water and Benzene

| Gm. mols. $CH_3C_6H_4NH_2$ per liter $H_2O$ layer(1) | Gm. mols. $CH_3C_6H_4NH_2$ per liter $C_6H_6$ layer(2) | $\frac{2}{1}$ |
|---|---|---|
| 0.0110 | 0.5570 | 50.6 |
| 0.0134 | 0.7382 | 55.1 |
| 0.0180 | 1.0710 | 59.5 |
| 0.0227 | 1.3510 | 59.5 |

Water and Hexane

| Gm. Mols. $CH_3C_6H_4NH_2$ per liter $H_2O$ layer(1) | Gm. Mols. $CH_3C_6H_4NH_2$ per liter $C_6H_{14}$ layer(2) | $\frac{2}{1}$ |
|---|---|---|
| 0.0121 | 0.0415 | 3.4 |
| 0.0160 | 0.0723 | 4.5 |
| 0.0207 | 0.1143 | 5.5 |
| 0.0392 | 0.2260 | 5.8 |

CRITICAL SOLUTION TEMPERATURES OF TOLUIDINES IN SEVERAL SOLVENTS.
(Thiry, 1925.)

| Solvent*. | Ortho Toluidine. Crit. sol. temp. | Ortho Toluidine. % $C_6H_4CH_3.NH_2(o)$ at C. s. t. | Meta Toluidine. Crit. sol. temp. | Meta Toluidine. % $C_6H_4CH_3.NH_2(m)$ at C. s. t. | Para Toluidine. Crit. sol. temp. | Para Toluidine. % $C_6H_4CH_3.NH_2(p)$ at C. s. t. |
|---|---|---|---|---|---|---|
| Methyl Cyclopentane.. | —10.9 | 27.5 | – | – | – | – |
| Ethyl » .. | — 8.3 | 40.0 | – | – | – | – |
| Methyl Cyclohexane... | — 6.6 | 44.0 | — 8.3 | 38.2 | – | – |
| Hexane..... | +21.1 | 36.0 | +21.3 | 47.7 | – | – |
| Methyl 3 Pentane..... | – | – | – | | +32.4 | 30.0 |
| Isohexane..... | +25.5 | 42.5 | – | - | +36.0 | 20.0 |

CRITICAL SOLUTION TEMPERATURES OF MIXTURES OF META TOLUIDINE AND OTHER SOLVENTS.
(Dessart, 1926.)

| Solvent | Crit. sol. temp. |
|---|---|
| Hexane | +21 |
| Cyclohexane | -18 (calc.) |
| Methyl hexane | 8 |

The author also gives the curves of separation of mixtures of meta toluidine and methyl cyclohexane and of meta toluidine and hexane.

Freezing-point data are given for mixtures of Toluidines and:

Acetic acid(23)(18)
Amino phenols(12)
Aniline(22)
Allyl phenyl thiourea(32)
Arsenic tri chloride(28)
Benzene(5)(22)(6)
Benzoic acid(18)(1)(31)
Benzo phenone(16)
Camphor(8)
Catechol(26)
Chloro phenols(3)
Cinnamic acid(18)
Cresols(28a)
Cyclohexane(5)(7)(22)
Di chloro benzene(6)
Di methyl oxalate(21)
Di nitro benzenes(14)
Di nitro toluenes(13)(14)
Di phenyl amine(31)
Guaiacol(29)
Hexane(5)
Hydroquinone(26)
Menthol(24)
Methyl cyclohexane(5)(7)
Naphthalene(31)
Naphthylamines(31)
Naphthols(25)(31)(33)(34)
Nitro benzene(17)
Nitro phenols(14)(24)(25)
Nitro toluene(4)
Nitroso dimethyl aniline (2)(10)
Phenol(9)(11)(25)(27)
Phthalic anhydride(18)
Pyrogallol(20)
Quinone(17)
Resorcinol(26)(31)
Salicylic acid(18)
Toluene(5)
Tri phenyl carbinol(19)
Tri phenyl methane(15)

(1) Baskov, 1913; (2) Bernoulli and Veillon, 1932; (3) Burnham and Madgin, 1936; (41) Crockford and Simmons, 1933; (5) Dessart, 1926; (6) Glass and Madgin, 1934; (7) Hortenberg, 1926; (8) Jefremow, 1915, 1916; (9) Kitran, 1924; (10) Kremann, 1904; (11) Kremann, 1906; (12) Kremann and Hohl, 1920; (13) Kremann, Hönigsberg and Mauermann, 1923; (14) Kremann and Petritschek, 1917; (15) Kremann, Odelga and Zawodsky, 1921; (16) Kremann and Schadinger, 1918; (17) Kremann, Sutter, Sitte, Strzelba and Dobolsky, 1922; (18) Kremann, Weber and Zechner, 1925; (19) Kremann and Wlk, 1919; (20) Kremann and Zechner, 1918; (21) Kremann, Zechner and Drazil, 1924; (22) Linard, 1925; (23) O'Connor, 1924; (24) Pawlewski, 1893; (25) Philip, 1903; (26) Philip and Smith, 1905; (27) Puschin, 1926b; (28) Puschin and Hrustanovic, 1938; (28a) Puschin and Sladovic, 1928; (29) Puschin and Vaic, 1927; (30) Puschin and Zivadinovic, 1933; , (31) Vignon, 1891; (32) Schischokin, 1930; (33) Kremann and Stroch-schneider, 1918; (34) Kremann, Lupfer and Zawodsky, 1920.

Solubility of Para Toluidine in Ethyl Alcohol.
(Speyers, 1902)

| t°. | Wt. of 1 cc. sat. sol. | Mols. $C_6H_4CH_3NH_2(p)$ per 100 mols. sat. sol. | Gms. $C_6H_4CH_3NH_2(p)$ per 100 gms. $C_2H_5OH$. |
|---|---|---|---|
| 0..... | 0.8885 | 20.72 | 60.8 |
| 5..... | 0.8982 | 26.0 | 82.0 |
| 10..... | 0.9080 | 32.0 | 107.0 |
| 15..... | 0.9180 | 38.6 | 145.0 |
| 20..... | 0.9265 | 47.0 | 206.0 |
| 25..... | 0.9360 | 56.0 | 340.0 |

100 gms. abs. alcohol dissolve 110.0 gms. *p*-toluidine at 20-25°.
(Pucher and Dehn, 1921.)

100 gms. pyridine dissolve 126 gms. *p* toluidine at 20°–25°. (Dehn, 1917.)
100 gms. aq. 50% pyridine dissolve 96.1 gms. *p* toluidine at 20°–25°. "

100 gms. sat. solution of p toluidine in liquid ammonia contain 41 gm. $CH_3C_6H_4NH_2$ at ? t°. (DeCarli, 1927.)

**o ANISIDINE** o $C_6H_4(OCH_3)NH_2$.

Reciprocal Solubility of Ortho Anisidine and Glycerol.
(Parvatiker and Mc Ewen, 1924.)

| t° of Miscibility. | Gms. Anisidine per 100 gms. sat. sol | t° of Miscibility. | Gms. Anisidine per 100 gms. sat. sol. |
|---|---|---|---|
| 141.0..... | 34.25 | 145.0..... | 61.25 |
| 143.0..... | 43.57 | 142.5..... | 73.09 |
| 144.5..... | 51.69 | | |

**p ANISIDINE** $C_6H_4(OCH_3).NH_2$.

Distribution between Benzene and Water at 25°.
(Farmer and Warth, 1904.)

| Gms. $C_6H_4(OCH_3).NH_3$ per 100 cc. | |
|---|---|
| $C_6H_6$ Layer. | $H_2O$ Layer. |
| 0.4356 | 0.0747 |
| 0.6662 | 0.1112 |
| 0.9010 | 0.1472 |

Freezing-point data are given by Aoyama and Morita, 1933, for mixtures of ortho anisidine and chlor anilines.

**1- PHENYL SEMI CARBAZIDE** $H_2NCON(C_6H_5)NH_2$.

Freezing-point data for mixtures of 1-phenyl semi carbazide and sym. diphenyl carbazide are given by Noller, 1930.

**TOLUENE SULFONAMIDES** o, m and p $CH_3.C_6H_4SO_2NH_2$.

Solubility of Each in Water at 25°. (Holleman and Caland (1911.)

| Compound. | Gms. Comp'd per Liter Sat. Sol. |
|---|---|
| Amine of *o* Toluene Sulfonic Acid | 1.624 |
| " " *m* " " " | 7.812 |
| " " *p* " " " | 3.156 |

Freezing-point data for mixtures of toluene sulfonamides are given by Dobrjansky, 1920 and by McKie, 1918.

**TOLYLENE DIAMINE** m $CH_3.C_6H_3(NH_2)_2$.

Determinations of the solubility of Tolylene diamine and other compounds in rubber, by means of microscope observations of prepared samples are described by Morris, 1932.

Tri thio Carbon Di **LACTYL ACID** HOOC.CH.$(CH_3)$S CS.S$(CH_3)$CH.COOH.

SOLUBILITY OF THE STEREOISOMERIC FORMS OF THIS ACID IN WATER AT 25°
(Holmberg, 1921.)

| Compound. | M. pt. ° ° | Gms. empd. per liter sat. sol. |
|---|---|---|
| Meso Tri thio carbon di lactyl acid ..... | 104–105 | 27.4 |
| Racem » » » » ..... | 154–155 | 3.03 |
| Dextro » » » » ..... | 136–136.5 | 10.6 |
| Laevo » » » » ..... | – | 10.6 |

**LACTOSE** (See Sugars, pages 711-715).

**XANTHOGEN SUCCINAMIDE.**

SOLUBILITY OF THE STEREOISOMERIC FORMS OF β XANTHOGEN SUCCINAMIDE ACID, HO OC.CH $(CS.OC_2H_5).CH_2$ CO $NH_2$, IN WATER AT 25°.
(Holmberg and Leander, 1917.)

| Isomeric Form. | M. pt. | Gm. mols. per liter. | Gms. per liter. |
|---|---|---|---|
| Inactive..... | 125°–126° | 0.0219 | 5.20 |
| Dextro..... | 134°–135° | 0.0190 | 4.50 |
| Laevo..... | 134°–135° | 0.0190 | 4.50 |

**METHYL CYCLO HEXANONE** $C_7H_{12}O$.

100 gms. $H_2O$ dissolve 2.2 gms. $C_7H_{12}O$ at 20°.

100 gms. 0.4 normal aq. sodium oleate solution (= 10.8 gms. Na oleate per 100 gms. solution) dissolve 22.5 gms. $C_7H_{12}O$ at 20°. The emulsions separate in 20 minutes. (Smith, 1932.)

Hexahydro**BENZOIC ACID** $CH_2(CH_2.CH_2)_2.CH.COOH$.

100 gms. $H_2O$ dissolve 0.201 gm. of the acid at 15°, *d.* saturated solution = 1.048.
(Lumsden, 1905.)

**HYDANTOIN of dl LEUCINE** $C_7H_{12}O_2N$.

SOLUBILITY OF HYDANTOIN OF dl LEUCINE IN AQUEOUS ETHYL ALCOHOL AT 25°.
(McMeekin, Cohn and Weare, 1935.)

| Vol. % $C_2H_5OH$ in aq. solvent | d. of sat. sol. | Gm. Mols. $C_7H_{12}O_2N$ per liter sat. sol. | Vol. % $C_2H_5OH$ in aq. solvent | d. of sat. sol. | Gm. Mols. $C_7H_{12}O_2N$ per liter sat. sol. |
|---|---|---|---|---|---|
| 0.0 | 0.9972 | 0.0124 | 80.0 | 0.8610 | 0.162 |
| 20.0 | 0.9730 | 0.0186 | 90.0 | 0.8314 | 0.154 |
| 40.0 | 0.9470 | 0.0444 | 100. | 0.7922 | 0.100 |
| 60.0 | 0.9107 | 0.0951 | | | |

**PIMELIC ACID** $(CH_2)_5(COOH)_2$.

DISTRIBUTION BETWEEN WATER AND ETHER AT 25°. (Chandler, 1908.)

| Mols. $(CH_2)_5(COOH)_2$ per Liter. | | Dist. Coef. $\frac{a}{b}$ | Dist. Coef. Corrected for Ionization. |
|---|---|---|---|
| Aq. Layer, *a*. | Ether Layer, *b*. | | |
| 0.00998 | 0.01407 | 0.7095 | 0.670 |
| 0.00702 | 0.00979 | 0.7170 | 0.670 |
| 0.00480 | 0.00667 | 0.7195 | 0.663 |
| 0.00284 | 0.00380 | 0.7480 | 0.663 |
| 0.00179 | 0.00253 | 0.7075 | 0.653 |

100 gms. benzene dissolve 0.0199 gm. $(CH_2)_5(COOH)_2$ at 25°. (Verkade and Coops, Jr., 1930.)

*r* β Methyl**ADIPIC ACID** $COOH.(CH_2)_3.CH.CH_3.COOH$.

100 gms. $H_2O$ dissolve 4.47 gms. *r* β $COOH.(CH_2)_3.CHCH_3.CO\ OH$ at 0°, and 14.43 gms. at 20°. (Meurisse.

**PROPYL SUCCINIC ACID** $CH_2CH(C_3H_7)(COOH)_2$.

Freezing-point data for mixtures of the optically active isomers of propyl succinic acid and hexyl succinic acid are given by Timmermans and van der Haegen, 1933.

**ETHYL MALONATE** $CH_2(COOC_2H_5)_2$.

100 cc $H_2O$ dissolve 2.08 gms. $CH_2(COOC_2H_5)_2$ at 20°. (Sobotka and Kahn, 1931.)

**BUTYL MALONIC ACID** (normal) $CH(C_4H_9)(COOH)_2$.

100 gms. $H_2O$ dissolve 106.7 gms. $CH(C_4H_9)(COOH)_2$ at 25°.
100 gms. $C_6H_6$ dissolve 0.044 gms. " " .

(Verkade and Coops, Jr. 1930a.

**TRI GLYCINE HYDANTOIC ACID** $C_7H_{12}O_5N_4$.

SOLUBILITY IN WATER AND IN ETHYL ALCOHOL AT 25°.
(McMeekin, Cohn and Weare, 1936.)

| Solvent | d. of sat. sol. | Gm. Mol. $C_7H_{12}O_5N_4$ per liter sat. sol. |
|---|---|---|
| Water | 1.0011 | 0.0446 |
| Ethyl alcohol | 0.7851 | 0.000077 |

**FORMYL LEUCINE** $(CH_3)_2CHCH_2CH.(NHCHO)COOH$.

SOLUBILITY OF FORMYL LEUCINE IN AQUEOUS ETHYL ALCOHOL AT 25°.
(McMeekin, Cohn and Weare, 1935.)

| Vol. % $C_2H_5OH$ in solvent | d. of sat. sol. | Gm. Mol. $C_7H_{13}O_3N$ per liter sat. sol. | Vol. % $C_2H_5OH$ in solvent | d. of sat. sol. | Gm. Mol. $C_7H_{13}O_3N$ per liter sat. sol. |
|---|---|---|---|---|---|
| 0.0 | 1.0006 | 0.185 | 70 | 0.9554 | 2.113 |
| 20 | 0.9807 | 0.364 | 80 | 0.9385 | 2.156 |
| 40 | 0.9714 | 1.163 | 90 | 0.9183 | 2.070 |
| 60 | 0.9622 | 1.9363 | 100 | 0.8726 | 1.792 |

**HEPTANE** *n* $CH_3(CH_2)_5CH_3$.

100 gm. sat. solution of heptane in water contain about 0.005 gm. $CH_3(CH_2)_5CH_3$ at 15°.5. (Fühner, 1924.)

100 gm. sat. solution of heptane in 92 wt. % alcohol contain 26.4 to 28.5 gms. $CH_3(CH_2)_5CH_3$ at 15°. (Ormandy and Craven, 1921.)

### Equilibrium in the System Normal Heptane, Phenol and Water.
(Vondracek and Dostal, 1936.)

The temperatures of appearance of opalescence in known mixtures were determined. The following values for 20° and 30° were obtained by graphical interpolation.

Results at 20°

| Gms. per 100 gms. homogeneous mixture | | |
|---|---|---|
| $C_7H_{14}$ | $C_6H_5OH$ | $H_2O$ |
| 8.77 | 86.89 | 4.34 |
| 6.22 | 85.27 | 8.51 |
| 4.82 | 82.78 | 12.40 |
| 3.96 | 80.06 | 15.98 |
| 3.37 | 77.22 | 19.30 |
| 2.96 | 74.68 | 22.36 |

TResults at 30°

| Gms. per 100 gms. homogeneous mixture | | |
|---|---|---|
| $C_7H_{14}$ | $C_6H_5OH$ | $H_2O$ |
| 10.29 | 85.44 | 4.27 |
| 7.27 | 84.32 | 8.42 |
| 5.59 | 82.12 | 12.29 |
| 4.60 | 79.53 | 15.86 |
| 3.84 | 76.95 | 19.21 |
| 3.39 | 74.35 | 22.27 |

The critical solution temperature of mixtures of normal heptane and liquid sulfur dioxide is 19° and the reciprocal solubility curve at this temperature is practically flat between the concentrations 50 and 90 mol. percent $SO_2$. (Leslie, 1934.)

Freezing-point data are given for mixtures of normal Heptane and:

| | |
|---|---|
| Benzene | (Ormandy and Craven, 1926.) |
| Phenol | (Campetti and Delgrosso, 1913.) |
| Tri methyl pentane | (Smittenberg, Hoog and Henkes, 1938.) |

## METHYL CYCLO HEXANE $C_6H_{11}CH_3$.

### Equilibrium in the System Methyl Cyclohexane, Phenol and Water.
(Vondracek and Dostal, 1936.)

The temperatures of appearance of opalescence in known mixtures were determined. The following values for 20° and 30° were obtained by graphical interpolation.

Results at 20°

| Gms. per 100 gms. homogeneous mixture | | |
|---|---|---|
| $C_6H_{11}CH_3$ | $C_6H_5OH$ | $H_2O$ |
| 21.14 | 75.11 | 3.75 |
| 17.31 | 77.29 | 5.40 |
| 13.74 | 78.43 | 7.83 |
| 10.18 | 78.12 | 11.70 |
| 8.40 | 76.36 | 15.24 |

Results at 30°

| Gms. per 100 gms. homogeneous mixture | | |
|---|---|---|
| $C_6H_{11}CH_3$ | $C_6H_5OH$ | $H_2O$ |
| 26.12 | 70.37 | 3.51 |
| 20.73 | 74.09 | 5.18 |
| 15.98 | 76.40 | 7.62 |
| 11.62 | 76.87 | 11.51 |
| 7.98 | 73.64 | 18.38 |

The critical solution temperature of mixtures of Methyl cyclo hexane and liquid Sulfur Dioxide is 15° and the reciprocal solubility curve at this temperature is practically flat between the concentrations 40 and 90 mol. percent $SO_2$. (Leslie, 1934.)

Freezing-point data are given for mixtures of Methyl cyclo hexane and:

Carbon disulfide(5) (Hexane(5) (Pentane(5)
Cyclohexane(4) Nitro toluene(1) Toluidine(1)(2)
Hydrobromic acid(3)

(1) Dessart, 1926; (2) Hortenberg, 1926; (3) Maass, Boomer and Morrison, 1923; (4) Timmermans, 1928; (5) Timmermans, 1934.

**OENANTHOL** (Enanthaldehyde) $CH_3(CH_2)_5CHO$.

FREEZING-POINTS OF MIXTURES OF OENANTHOL AND WATER. (Noorduyn, 1919.)

| t° of f. pt. | Mol. per cent $C_7H_{14}O$ in mixture. | Solid Phase. |
|---|---|---|
| −42 | 100 | $C_7H_{14}O$ |
| −42.5 (Eutec.) | trace $H_2O$ present | » + $C_7H_{14}O.H_2O$ |
| +11.4 | 90 | $C_7H_{14}O.H_2O$ + two liquid layers |
| +11.4 | 0.019 | » + » |
| − 0.058 (Eutec.) | 0.016 | $C_7H_{14}O.H_2O$ + Ice |
| 0.0 | 0.0 | Ice |

The solubility of oenanthol in water at 11°.4 was found to be 0.124 gm. (=0.019 gm. mol.) $C_7H_{14}O$ per 100 gms. sat. sol.

**HEPTYL ALCOHOL** *n* $CH_3(CH_2)_5CH_2OH$.

SOLUBILITY OF *n* HEPTYL ALCOHOL IN WATER. (Führer, 1024.)

The determinations were made by the synthetic method and from the curve obtained, the following results were read.

| t° | 70°. | 80°. | 90°. | 100°. | 110°. | 120°. | 130°. |
|---|---|---|---|---|---|---|---|
| Gms. $CH_3(CH_2)_5CH_2OH$ per 100 gm. sat. sol. | 0.125 | 0.170 | 0.225 | 0.285 | 0.355 | 0.43 | 0.515 |

An approximate determination at 18° gave 0.10 gm. per 100 gm. sat. sol.

100 gms. sat. solution of normal Heptyl alcohol in water contain 0.181 gms. $CH_3(CH_2)_5CH_2OH$ at 25°. (Butler, Thomsen and Maclennon, 1933.)

**DIPROPYL KETONE** $(C_3H_7)_2CO$.

SOLUBILITY OF DIPROPYL KETONE IN WATER.
(Gross, Rintelen and Saylor, 1939.)

| t° | Gm. Mols. $(C_3H_7)_2CO$ per 1000 gms. $H_2O$ |
|---|---|
| 0 | 0.0643 |
| 10 | 0.0466 |
| 30 | 0.0335 |
| 50 | 0.0288 |
| 75 | 0.0272 |

**METHYL AMYL KETONE** $(CH_3)(C_5H_{11})CO$.

100 gms. sat. sol. of methyl amyl ketone in water contain 1.95 gms. $CH_3(C_5H_{11})CO$ at 25°.
100 gms. sat. sol. of water in methyl amyl ketone contain 2.15 gms. $H_2O$ at 25°. (Park and Hofman, 1932.)

**UREIDE OF GLUCOSE** $CH_2OH.(CHOH)_4.CH : N.CO.NH_2$.

100 gms. absolute ethyl alcohol dissolve 0.04 gm. ureide of glucose at 25°.
" 85.6% " " 0.73 " " " "
" methyl alcohol " " 0.22 " " " (Schoorl, 1903.)

**AMYL ACETATES** (normal and iso) $CH_3.COOC_5H_{11}$.

100 cc $H_2O$ dissolve 0.2 cc normal amyl acetate at 20°.
100 cc $H_2O$ dissolve 0.2 cc (1.2?) iso amyl acetate at 20°. (Traube, 1884; Bancroft, 1895.)

100 cc $H_2O$ dissolve 0.2 cc secondary amyl acetate at 25°. (Park and Hopkins, 1930.)

RECIPROCAL SOLUBILITY OF AMYL ACETATES, ETHYL ALCOHOL AND WATER.
(Pfeiffer, 1892.)

Results for Normal Amyl Acetate

| Composition of Homogeneous Mixture | | |
|---|---|---|
| cc $C_7H_{14}O_2$(n) | cc $C_2H_5OH$ | cc $H_2O$ |
| 3.0 | 3.0 | 1.76 |
| 3.0 | 9.0 | 9.03 |
| 3.0 | 15.0 | 17.52 |
| 3.0 | 21.0 | 26.99 |
| 3.0 | 27.0 | 37.23 |
| 3.0 | 33.0 | 48.41 |

Results for Iso Amyl Acetate

| Composition of Homogeneous Mixture | | |
|---|---|---|
| cc $C_7H_{14}O_2$(iso) | cc $C_2H_5OH$ | cc $H_2O$ |
| 0.41 | 5.0 | 7.0 |
| 0.7 | 5.0 | 6.0 |
| 1.31 | 5.0 | 5.0 |
| 3.0 | 5.0 | 3.61 |
| 4.0 | 5.0 | 3.01 |
| 5.0 | 5.0 | 2.60 |

## PROPYL BUTYRATE $C_3H_7COOC_3H_7$.

100 gms. $H_2O$ dissolve 0.162 gm. $C_7H_{14}O_2$ at 17°. (Fühner, 1924.)

RECIPROCAL SOLUBILITY OF PROPYL BUTYRATE ETHYL ALCOHOL AND WATER.
(Bancroft, 1895.)

| Composition of Homogeneous Mixtures | | |
|---|---|---|
| cc $C_7H_{14}O_2$ | cc $C_2H_5OH$ | cc $H_2O$ |
| 3.0 | 3.0 | 1.19 |
| 3.0 | 6.0 | 3.55 |
| 3.0 | 9.0 | 6.13 |
| 3.0 | 12.0 | 9.05 |
| 3.0 | 15.0 | 12.31 |
| 3.0 | 18.0 | 15.90 |
| 3.0 | 21.0 | 19.68 |
| 3.0 | 24.0 | 23.72 |
| 3.0 | 30.0 | 32.10 |
| 3.0 | 36.0 | 41.55 |
| 3.0 | 42.0 | 51.60 |
| 3.0 | 48.0 | 62.40 |
| 3.0 | 54.0 | 73.85 |

## n BUTYL PROPIONATE $C_3H_7COOC_3H_7$.

100 cc $H_2O$ dissolve 0.2 cc n butyl propionate at 25°. (Park and Hopkins, 1930.)

## ETHYL VALERATES (normal and iso) $C_4H_9COOC_2H_5$.

100 cc $H_2O$ dissolve 0.3 cc ethyl valerate at 25°.
100 cc $H_2O$ dissolve 0.2 cc ethyl iso valerate at 20°.
100 cc ethyl iso valerate dissolve 0.4 + cc $H_2O$ at 20°.
(Pfeiffer, 1892; Bancroft, 1895.)

RRECIPROCAL SOLUBILITY OF ETHYL VALERATES, ETHYL ALCOHOL AND WATER.
(Pfeiffer, 1892; Bancroft, 1895.)

Results for Ethyl Normal Valerate

| Composition of Homogeneous Mixtures | | |
|---|---|---|
| cc $C_7H_{14}O_2$(n) | cc $C_2H_5OH$ | cc $H_2O$ |
| 3.0 | 3.0 | 1.42 |
| 3.0 | 15.0 | 14.13 |
| 3.0 | 27.0 | 31.62 |
| 3.0 | 39.0 | 53.13 |
| 3.0 | 57.0 | 90.53 |
| 3.0 | 81.0 | 180.0 |

Results for Ethyl Iso Valerate

| Composition of Homogeneous Mixtures | | |
|---|---|---|
| cc $C_7H_{14}O_2$(iso) | cc $C_2H_5OH$ | cc $H_2O$ |
| 0.15 | 5.0 | 10 |
| 0.23 | 5.0 | 8 |
| 0.46 | 5.0 | 6 |
| 0.72 | 5.0 | 5 |
| 1.23 | 5.0 | 4 |

*iso* Amyl**ACETIC ACID** $C_5H_{11}CH_2COOH$.

DISTRIBUTION OF ISO AMYLACETIC ACID BETWEEN WATER AND XYLENE AT 23°.
(Smith, 1921-1922.)

| Millimols. *iso* $C_5H_{11}.CH_2.COOH$ per liter of | | |
|---|---|---|
| $H_2O$ layer ($C_1$). | Xylene layer ($C_2$). | $\frac{C_2}{C_1}$. |
| 0.0792 | 0.858 | 10.85 |
| 0.212 | 2.170 | 10.25 |
| 0.375 | 3.625 | 9 67 |
| 0.85 | 7.95 | 9.37 |

**ENANTHIC ACID** (Heptoic, Heptylic) $CH_3(CH_2)_5COOH$.

100 gms. $H_2O$ dissolve 0.241 gm. $CH_3(CH_2)_5COOH$ at 15°. (Lumsden, 1905.)
100 gms. $H_2O$ dissolve 0.22 gm. $CH_3(CH_2)_5COOH$ at 20°. (Lipetz and Rimskaja, 1931.)

Results for the distribution of Enanthic acid between water and olive oil at 23° are given by Bodansky, 1928.

**AMINO CAPROIC HYDANTOIC ACIDS**, α and Ε, $C_7H_{14}O_3N_2$.

SOLUBILITY OF EACH SEPARATELY IN WATER AND OTHER SOLVENTS AT 25°.
(McMeekin, Cohn and Weare, 1936.)

| | α Amino Caproic Hydantoic Acid m. pt. = 169-70° | | Ε Amino Caproic Hydantoic Acid m. pt. = 179-80° | |
|---|---|---|---|---|
| Solvent in each case | d. of sat. solution | Gm. Mols. $C_7H_{14}O_3N_2$ per liter sat. sol. | d. of sat. solution | Gm. Mols. $C_7H_{14}O_3N_2$ per liter sat. sol. |
| Water | 0.99727 | 0.0069 | 0.99725 | 0.0069 |
| Formamide | 1.13141 | 0.165 | — | — |
| Methanol | 0.79390 | 0.1123 | — | — |
| 80 % Ethanol | 0.85947 | 0.0867 | 0.85690 | 0.0322 |
| 90 % Ethanol | 0.82920 | 0.0803 | 0.82619 | 0.0228 |
| 100 % Ethanol | 0.78885 | 0.0477 | 0.78639 | 0.00756 |
| Butanol | 0.80739 | 0.01786 | 0.80643 | 0.00278 |
| Acetone | 0.78588 | 0.00463 | — | — |

i **BUTYL URETHAN** $C_4H_9.NH.COOC_2H_5$.

100 gms. $H_2O$ dissolve 2.042 gms. $C_7H_{15}O_2N$ at 15.5°. (Führer, 1924.)

**2- METHYL HEXANE** $(CH_3)_2CH(CH_2)_2CH_2CH_3$.

The critical solution temperature of mixtures of 2-Methyl Hexane and Sulfur Dioxide is 18° and the reciprocal solubility curve at this temperature is practically flat between the concentrations 38 and 83 mol. percent $SO_2$. (Leslie, 1934.)

**2,2,3-TRI METHYL BUTANE** $CH_3C(CH_3)_2CH(CH_3)CH_3$.

Freezing-point data for mixtures of tri and tetra methyl butane are given by Smittenberg, Hoog and Henkes, 1938.

**HEPTANE** $C_7H_{16}$.

100 gms. $H_2O$ dissolve 0.005 gm. $C_7H_{16}$ at 15.5°. (Führer, 1924.)

## n HEPTYL ALCOHOL

### Solubility of n Heptyl Alcohol in Water.
(Fühner, 1924.)

| t° | Gms. $C_7H_{16}O$ per 100 gms. $H_2O$ | t° | Gms. $C_7H_{16}O$ per 100 gms. $H_2O$ |
|---|---|---|---|
| 18 | 0.10 | 100 | 0.285 |
| 70 | 0.125 | 110 | 0.355 |
| 80 | 0.17 | 120 | 0.430 |
| 90 | 0.225 | 130 | 0.515 |

100 gms. sat. solution of normal heptanol in water contain 0.18 gm. $C_7H_{16}O$ at 25°. (Butler, Thomson and Maclennon, 1933.)

### Reciprocal Solubility of Isomeric Heptanols and Water.
(Ginnings and Hauser, 1938.)

| Heptanol | b. pt. of heptanol | d. of heptanol | t° | Gms. heptanol per 100 gms. sat. sol. in $H_2O$ | Gms. $H_2O$ per 100 gms. sat. sol. in heptanol |
|---|---|---|---|---|---|
| 2,3,3-Trimethyl butanol-2 | 130.3-.8 | 0.8380 | 40 | 2.20(0.8352) | 5.28(0.9902) |
| 3-Ethyl pentanol-3 | 143.1-.2 | 0.8402 | 20 | 1.91(0.8541) | 5.75(0.9964) |
| " " | " | " | 25 | 1.68(0.8502) | 5.76(0.09957) |
| " " | " | " | 30 | 1.50(0.8457) | 5.79(0.9945) |
| " " | " | " | 40 | 1.26(0.8366) | 5.69(0.9921) |
| 2,3-Dimethyl pentanol-3 | 139.6-.8 | 0.8365 | 20 | 1.87(0.8513) | 5.89(0.9965) |
| " " | " | " | 25 | 1.64(0.8470) | 5.88(0.9961) |
| " " | " | " | 30 | 1.43(0.8430) | 5.88(0.9945) |
| 2,3-Dimethyl pentanol-2 | 138.5-139.0 | 0.8307 | 20 | 1.69(0.8477) | 6.31(0.9964) |
| " " | " | " | 25 | 1.54(0.8441) | 6.31(0.9955) |
| " " | " | " | 30 | 1.40(0.8404) | 6.29(0.9943) |
| 2,4-Dimethyl pentanol-2 | 132.5-133.5 | 0.8100 | 20 | 1.50(0.8279) | 6.51(0.9962) |
| " " | " | " | 25 | 1.34(0.8240) | 6.52(0.9954) |
| " " | " | " | 30 | 1.22(0.8199) | 6.51(0.9943) |
| 3-Methyl hexanol-3 | 142.7-.9 | 0.8202 | 20 | 1.35(0.8348) | 5.22(0.9967) |
| " " | " | " | 25 | 1.19(0.8312) | 5.25(0.9958) |
| " " | " | " | 30 | 1.07(0.8272) | 5.27(0.9946) |
| 2-Methyl hexanol-2 | 143.0-.2 | 0.8093 | 20 | 1.08(0.8268) | 6.22(0.9967) |
| " " | " | " | 25 | 0.97(0.8233) | 6.35(0.9958) |
| " " | " | " | 30 | 0.87(0.8199) | 6.44(0.9946) |
| 2,2Dimethyl pentanol-3 | 134.7-135.1 | 0.8224 | 20 | 0.88(0.8329) | 3.00(0.9971) |
| " " | " | " | 25 | 0.82(0.8289) | 3.06(0.9962) |
| " " | " | " | 30 | 0.79(0.8253) | 3.12(0.9950) |
| 2,4Dimethyl pentanol-3 | 138.4-.9 | 0.8254 | 20 | 0.78(0.8351) | 3.21(0.9974) |
| " " | " | " | 25 | 0.70(0.8315) | 3.32(0.9965) |
| " " | " | " | 30 | 0.67(0.8271) | 3.44(0.9955) |

The figures in parentheses are densities of the saturated solutions.

**SULFONAL** $(CH_3)_2C(SO_2C_2H_5)_2$.

SOLUBILITY OF SULFONAL IN SEVERAL SOLVENTS. (Falck, 1919.)

Constant agitation was employed and equilibrium was approached from above and below. The aqueous saturated solutions were analyzed by extracting with chloroform, evaporating and weighing the residue.

| Solvent. | t°. | Gms. $(CH_3)_2C(SO_2C_2H_5)_2$ per 100 gms. sat. sol. | Solver | t°. | Gms. $(CH_3)_2C(SO_2C_2H_5)_2$ per 100 gms. sat. sol. |
|---|---|---|---|---|---|
| Water ..... | 18. | 0.236 | Chloroform ..... | 20. | 23.26 |
| » ..... | 37. | 0.448 | Methylene chloride ($CH_2Cl_2$). | 20. | 26.13 |
| » ..... | 100. | 11.11 | Benzene ..... | 17. | 7.32 |
| Aq. 2 % NaCl... | 18. | 0.231 | Ethyl Acetate ..... | 20. | 6.77 |
| Aq. 90 % Alcohol. | 16. | 1.642 | Toluene ..... | 20. | 4.93 |
| Ether ..... | 15. | 1.25 | Carbon Tetrachloride ..... | 20. | 0.90 |
| » ..... | 17. | 1.33 | Carbon Disulfide ..... | 20. | 0.226 |
| » ..... | 19. | 1.47 | Aq. Urethan* ..... | 17. | 1.57 |

*Composed of 1 part Urethan + 1 1/2 parts Water, $d = 1.0455$.

10 cc. of horse serum dissolve 0.015 gm. sulfonal at 20°. The distribution between horse serum in contact with olive oil was 0.0123 gm. sulfonal per 10 cc. of serum layer and 0.0027 gm. per 10 cc. of olive oil layer. (Aiello, 1921.)

100 gms. benzene dissolve 0.76(?) gms. Sulfonal at 25°. (Warren, 1933.)

100 gms. sat. sol. of Sulfonal in 95.2 Vol. % $C_2H_5OH$ contain 14.41 gms. $C_7H_{16}O_4S_2$ at 25°.

100 gms. sat. sol. of Sulfonal in 94.9 Vol. % $C_2H_5OH$ contain 13.36 gms. $C_7H_{16}O_4S_2$ at 25°. (Schnellbach and Rosin, 1931.)

Ethyl and Methyl Sulfon **METHANES.**

SOLUBILITY IN WATER AND IN 90% ALCOHOL.

| Compound. | Formula. | t° | Gms. Cmpd. per 100 cc.: Water. | 90% Alcohol | Authority. |
|---|---|---|---|---|---|
| Sulfonal | $(CH_3)_2C(SO_2C_2H_5)_2$ | 15.5 | 0.22 | 1.25 | (Greenish and Smith, 1903.) |
| Tetronal | $(C_2H_5)_2C(SO_2C_2H_5)_2$ | 15–20 | 0.18 | 8.33 | (Squire and Caines, 1905.) |
| Trional | $(CH_3)(C_2H_5)C(SO_2C_2H_5)_2$ | 15–20 | 0.31 | 9.0 | " " " |

100 gms. petroleum ether dissolve 0.41 gms. Trional at 25°. (Warren, 1933.)

Freezing-point data for mixtures of Sulfonal and:

Acetanilide(2)(3)
" + Phenacetine(2)
" + Salipyrine(4)
Antipyrine(2)
" + Phenacetine(2)
" + Urea(5)
" + Salipyrine(5)
β Naphthol(1)
Naphthol + Salol(1)
Phenacetine(2)(3)
" + Acetanilide(2)
" + Antipyrine(2)
" + Urea(2)
" + Resorcinol(2)
Resorcinol(2)(3)
" + Phenacetine(2)
Salipyrine(3)
" + Acetanilide(4)
" + Urea(5)
Salol(6)
" + β Naphthol(1)
Urea(2)(3)
" + Antipyrine(5)
" + Phenacetine(2)

(1) Bianchini, 1914; (2) Hrynakowski, 1934; (3) Hrynakowski and Adamanis, 1933a; (4) Hrynakowski and Staszewski, 1936, (5) Hrynakowski and Szmyt, 1938a; (6) Quercigh and Cariagnari, 1913.

**HEPTYL AMINE** *n* $CH_3(CH_2)_5CH_2NH_2$.

DISTRIBUTION OF HEPTYL AMINE AT 25° BETWEEN : (Smith, 1921, 1922.)

Water and Ether.

| Millimols. per liter. | | |
|---|---|---|
| $H_2O$ layer ($C_1$). | $(C_2H_5)_2O$ layer ($C_2$). | $\frac{C_2}{C_1}$. |
| 0.120 | 1.41 | 11.75 |
| 0.200 | 3.105 | 15.5 |
| 0.275 | 5.145 | 18.7 |
| 0.385 | 8.00 | 20.8 |

Water and Xylene.

| Millimols. per liter. | | |
|---|---|---|
| $H_2O$ layer ($C_1$). | $C_6H_4(CH_3)_2$ layer ($C_2$). | $\frac{C_2}{C_1}$. |
| 0.083 | 0.917 | 11.0 |
| 0.152 | 1.848 | 12.3 |
| 0.270 | 3.730 | 13.8 |
| 0.438 | 9.562 | 21.8 |
| 0.445 | 9.565 | 21.5 |

**TRI BROMO PHENOL ACETATE** $CH_3COOC_6H_2Br_3$.

Freezing-point data for mixtures of Tribromo Phenol Acetate and s Tribromo phenol are given by Boeseken, 1912.

**TRI FLUO TOLUIC ACID** o $C_6H_4CF_3COOH$.

100 cc $H_2O$ dissolve 0.48 gm. o $C_6H_4CF_3COOH$ at 25°. (Brouwer, 1930.)

**PHTHALIMIDE** *o* $C_6H_4 < (CO)_2 > NH$.

100 gms. $H_2O$ dissolve 0.06 gm. phthalimide at 20–25°. (Dehn, 1917.)
" pyridine " 14.15 gms. " " " "
" aq. 50% pyridine " 7.74 " " " " "

**PHTHALIC ANHYDRIDE** $C_6H_4 < \begin{matrix} CO \\ CO \end{matrix} > O$.

SOLUBILITY IN WATER.
(van der Stadt, 1902.)

All determinations, except first three, made by the Synthetic Method. See p. 292

| t°. | Gms. $C_8H_4O_3$ per 100 Gms. | | Mol. per cent $C_8H_4O_3$. | t°. | Gms. $C_8H_4O_3$ per 100 Gms | | Mol. per cent $C_8H_4O_3$. |
|---|---|---|---|---|---|---|---|
| | Water. | Solution. | | | Water. | Solution. | |
| 0 | 0.00295 | 0.00295 | 0.00036 | 189.5 | 1076 | 91.66 | 56.73 |
| 25 | 0.6194 | 0.6150 | 0.0754 | 188.8 | 1265 | 92.68 | 60.63 |
| 50 | 1.630 | 1.604 | 0.198 | 187.1 | 1474 | 93.65 | 64.22 |
| 135.9 | 94.3 | 48.54 | 10.30 | 181.8 | 2332 | 95.88 | 73.95 |
| 165.4 | 210 | 67.75 | 20.36 | 176.2 | 3334 | 97.07 | 80.23 |
| 179.4 | 319.3 | 76.13 | 27.98 | 169.4 | 5745 | 98.28 | 87.49 |
| 186.2 | 449.6 | 81.81 | 35.37 | 130.9 | 37570 | 99.72 | 97.89 |
| 189.6 | 546.1 | 84.50 | 39.93 | 131 | 83010 | 99.86 | 99.02 |
| 191 | 821.5 | 89.19 | 50 | 131.2 | ∞ | 100 | 100 |
| 190.4 | 863.4 | 89.62 | 51.24 | | | | |

SOLUBILITY OF PHTHALIC ANHYDRIDE IN CARBON DISULFIDE.
(Arctowski, 1895; Etard, 1894.)

| t°. | Gms. $C_8H_4O_3$ per 100 Gms. Solution. | t°. | Gms. $C_8H_4O_3$ per 100 Gms. Solution. | t°. | Gms. $C_8H_4O_3$ per 100 Gms. Solution. |
|---|---|---|---|---|---|
| −112.5 | 0.013 | +10 | 0.3 | 70 | 2.3 |
| −93 | 0.013 | 20 | 0.7 | 90 | 3.7 |
| −77.5 | 0.016 | 30 | 0.8 | 100 | 5 |
| −40 | 0.03 | 40 | 1.2 | 120 | 8 |
| −20 | 0.06 | 50 | 1.3 | 140 | 13.3 |
| −10 | 0.10 | 60 | 1.7 | 160 | 20.7 |
| 0 | 0.20 | | | 180 | 30.2 |

100 gms. 95% formic acid dissolve 4.67 gms. phthalic anhydride at 19.8°. (Aschan, 1913.)
100 gms. pyridine dissolve 83.5 gms. phthalic anhydride at 20–25°. (Dehn, 1917.)

Freezing-point data are given for mixtures of:

Phthalic anhydride + Butyl phthalate (Lombaers, 1924.)
" " + Sec. Butyl alcohol " "
" " + Naphthylene (Monroe, 1919.)
" " + Phthalic acid " "
" " + p Toluidine (Puschin and Zwadinovic, 1933.)
" " + Phthalimide (Grimm, Gunther and Titus, 1931.)

Active and Racemic Phthalic acid mono butyl esters. (Lombaers, 1924.)

**PHTHALYL CHLORIDE** $C_6H_4(COOCl)_2$.

Freezing-point data for mixtures of symetrical (m. pt. 15°-16°) and asymetrica (m. pt. 88°-89°) phthalyl chloride are given by Csanyi, 1919.

**Nitro PHTHALIC ACIDS** *o* and *m* (Iso) $C_6H_3(NO_2)(COOH)_2$.

SOLUBILITY OF THE SEVERAL NITRO PHTHALIC ACIDS IN WATER AT 25°.
(Holleman and Huisinga, 1908.)

| Acid. | M. pt. | Gms. Acid per 100 Gms. Sat. Solution. |
|---|---|---|
| α Nitro Ortho Phthalic Acid | 220 | 2.048 |
| β " " " " | 164–166 | very soluble |
| Symmetrical Nitro Iso Phthalic Acid (anhy.) | 255–256 | 0.220 |
| " " " " (hydrated) | 255–256 | 0.157 |
| Asymmetrical " " " | 245 | 0.967 |
| Vicinal " " " | 300 | 0.216 |

The authors also give several tables showing the solubility of one of the above compounds in aqueous solutions of another. These data are made the basis of an ingenious solubility method for determining the composition of unknown mixtures of these compounds.

**PENTA NITRO PHENYL ETHANE** 2,4,6,2',4' $C_2H_3(NO_2)_2.C_6H_2(NO_2)_3$.

100 gms. $H_2O$ dissolve 0.007 gm. penta nitro phenyl ethane at 27°, 0.017 gm. at 50° and 0.095 gm. at 100°. (Desvergnes, 1926.)

Ortho **PHTHALDEHYDE** $C_6H_4(CHO)_2$.

SOLUBILITY IN WATER BY DETERMINED THE FREEZING-POINT METHOD.
(Seekles, 1923.)

| 1st. f. pt. | 2nd. f. pt. | Mol. % $C_6H_4(CHO)_2$. | 1st. f. pt. | 2nd. f. pt. | Mol. % $C_6H_4(CHO)_2$ |
|---|---|---|---|---|---|
| 53.2 | – | 100 | 45.4 | – | 0.693* |
| 46.9 | 45.1 | 63.97 | 35.0 | – | 0.68* |
| 45.6 | – | 57.05 | 25.0 | – | 0.662* |
| 45.4 | 45.0 | 54.10 | 15.0 | (60) | 0.637* |
| 45.2 | – | 52.81 | – | −0.61 | 0.64 |
| 45.0 | – | 51.45 | −0.55 | – | 0.552 |
| 45.3 | ±57) | 50.00 | −0.44 | – | 0.463 |
| 45.2 | 45.0 | 48.45 | −0.38 | – | 0.374 |
| 45.4 | 45.0 | 47.03 | −0.30 | – | 0.285 |
| 45.4 | (45.4) | 45.68 | −0.09 | – | 0.089 |
| 45.4 | (45.4) | 38.73 | −0.05 | – | 0.036 |
| 45.4 | (45.4) | 33.33 | 0.0 | – | 0.0 (= $H_2O$) |

The figures in parentheses show the temperatures of separation.

* These determinations were made by direct measurement of the solubility of the compound in water the results show the formation of the monohydrate $C_6H_4(CHO)_2.H_2O$.

PHTHALIDE $C_6H_4COOCH_2$.

Freezing-point data for mixtures of phthalide with acetamide and with tri phenyl guanidines are given by Lautz, 1913.

**PHENYL** Dichlor **ACETATE** $C_6H_5Cl_2C.COOH$.

Freezing-point lowering data are given for mixtures of phenyl dichlor acetate and phenyl chloro brom acetate by Crompton and Triffitt, 1921.

Aldehydo **BENZOIC ACIDS** $COOH.C_6H_4CHO$.

SOLUBILITY OF ORTHO, META AND PARA ALDEHYDO BENZOIC ACIDS IN WATER.
(Sidgwick and Clayton, 1922.)

| Results for *o* $COOH.C_6H_4.CHO$. | | | Results for *m* $COOH.C_6H_4.CHO$. | | Results for *p* $COOH.C_6H_4.CHO$. | |
|---|---|---|---|---|---|---|
| Temp. of | | | | | | |
| solid-liquid equilibrium. | liquid-liquid equilibrium. | Gms. *o* $COOH.C_6H_4CHO$ per 100 gms. sat. sol. | Temp. of solid-liquid equilibrium. | Gms. *m* $COOH.C_6H_4CHO$ per 100 gms. sat. sol. | Temp. of solid-liquid equilibrium. | Gms. *p* $COOH.C_6H_4CHO$ per 100 gms. sat. sol. |
| 100.5 | – | 100.0 | 175.0 | 100.0 | 250.0 | 100 |
| 75.0 | – | 91.66 | 140.0 | 86.76 | 191.5 | 79.40 |
| 64.5 | – | 87.20 | 132.9 | 81.88 | 181.5 | 49.60 |
| 58.1 | – | 81.50 | 121.5 | 70.72 | 158.9 | 32.46 |
| 53.2 | 39.2 | 59.48 | 116.6 | 58.87 | 150.9 | 19.08 |
| 51.8 | 44.0 | 40.83 | 114.6 | 49.45 | 142.3 | 10.24 |
| 49.9 | 45.75 | 29.20 | 113.5 | 40.28 | | |
| 48.92 | 43.3 | 20.00 | 112.3 | 29.97 | | |
| 46.1 | 21.1 | 9.38 | 110.7 | 19.87 | | |
| | | | 107.5 | 11.22 | | |
| | | | 99.7 | 4.91 | | |

Solubility of Ortho, Meta and Para Aldehydo Benzoic Acids in Benzene.

(Sidgwick and Clayton, 1922.)

| Results for $o$ $COOH.C_6H_4CHO$. | | Results for $m$ $COOH.C_6H_4.CHO$. | | Results for $p$ $COOH.C_6H_4.CHO$. | |
|---|---|---|---|---|---|
| Temp. of solid-liquid equilibrium. | Gms. $o$ $COOH.C_6H_4.CHO$. per 100 gms. sat. sol. | Temp. of solid-liquid equilibrium. | Gms. $m$ $COOH.C_6H_4.CHO$ per 100 gms. sat. sol. | Temp. of solid-liquid equilibrium. | Gms. $p$ $COOH.C_6H_4CHO$ per 100 gms. sat. sol. |
| 84.0 | 81.4 | 175.0 | 100 | 250.0 | 100 |
| 77.8 | 64.09 | 154.5 | 73.36 | 196.0 | 2.40 |
| 75.7 | 49.50 | 149 9 | 56.98 | 131.9 | 1.41 |
| 73.9 | 35.88 | 149.7 | 43.84 | 110.0 | 0.96 |
| 72.3 | 21.87 | | | | |
| 66.7 | 10.16 | | | | |

**PIPERONAL** $CH_2<O_2>C_6H_3.CHO$,

100 gms. Carbon Tetrachloride dissolve 69.5 gms. $CH_2<O_2>C_6H_3.CHO$ at 20°.
» Chloroform » 200.8 » »

(Pawlewski, 1914, 1926.)

Freezing-point data are given for mixtures of piperonal and:

Acetic anhydride(2)
Aceto phenone(1)
Benzoic acid(3)(7)
Chlor acetic acid(3)(4)
Di phenyl amine(5)
Phosphorus acid(6)
Piperonylidene di acetate(2)
Tri chlor acetic acid(3)

Results are also given for Nitropiperonal + Tri chlor acetic acid(3)

(1) Fazi, 1916; (2) Jorissen and vander Beek, 1924; (3) Kendall and Gibbons, 1915; (4) Mameli and Mannessier, 1913; (5) Puschin and Zividanovic, 1933; (6) Redfield and King, 1936; (7) Passerini, 1924.

**BENZOYL FORMIC ACID** $C_6H_5CO.COOH$.

100 gms. $H_2O$ dissolve 318 gms. $C_6H_5CO.COOH$ at 0°. (Corson, Sanborn and Van Ess, 1930.)

**PIPERONYLIC ACID** $CH_2<O_2>C_6H_3.COOH$.

Distribution of Piperonylic Acid at 25° Between: (Smith, 1921, 1922.)

Water and Chloroform.

| Millimols. $CH_2<O_2>C_6H_3COOH$ per liter of | | $\frac{C_2}{C_1}$. |
|---|---|---|
| $H_2O$ layer ($C_1$). | $CHCl_3$ layer ($C_2$). | |
| 0.175 | 0.5812 | 3.32 |
| 0.2187 | 0.8125 | 3.71 |
| 0.250 | 1.0375 | 4.15 |

Water and Xylene.

| Millimols. $CH_2<O_2>C_6H_3COOH$ per liter of | | $\frac{C_2}{C_1}$. |
|---|---|---|
| $H_2O$ layer ($C_1$). | Xylene layer ($C_2$). | |
| 0.3595 | 0.3142 | 0.875 |
| 0.660 | 0.779 | 1.182 |
| 0.865 | 1.14 | 1.32 |

**PHTHALIC ACIDS** $C_6H_4(COOH)_2$, *o*, *m* and *p*.

Solubility of Each in Water. (Vaubel, 1895, 1899.)

| Acid. | $t°$. | Gms. per 100 Gms. Solution. |
|---|---|---|
| *o* Phthalic Acid | 14 | 0.54 |
| *m* = Isophthalic Acid | 25 | 0.013 |
| *p* = Terephthalic Acid | ... | almost insoluble |

Melting Temperatures of Mixtures of *o* Phthalic Acid and Water.
(Flaschner and Rankin, 1910.)

(The determinations were made by the sealed tube method of Alexejew.)

| Wt. % Acid | 14.4 | 28.2 | 39.6 | 49.3 | 75 | 100 |
|---|---|---|---|---|---|---|
| Saturation Temp. | 97° | 111.5° | 121.2° | 130° | 162° | 231° |
| Unstable boundary | ... | ... | ... | 27° | 84° | ... |

## PHTHALIC ACID $C_6H_4(COOH)_2(o)$.

### Solubility of Phthalic Acid in Water and in Aqueous Sodium Sulfate Solutions. (Mc Master, Bender and Weil, 1921.)

Saturation was secured by constant stirring and by approaching equilibrium from above and from below.

| | Gms. $C_6H_4(COOH)_2(o)$ per 100 gms. saturated solution in | | |
|---|---|---|---|
| t. | Water. | Aq. 10 % $Na_2SO_4$. | Aq. 15 % $Na_2SO_4$. |
| 25 | 0.7014 | 0.6440 | 0.5272 |
| 35 | 1.0125 | 0.9338 | 0.7575 |
| 45 | 1.446 | 1.341 | 1.080 |
| 55 | 2.168 | 1.858 | 1.639 |
| 65 | 3.246 | 3.018 | 2.445 |
| 75 | 4.926 | 4.373 | 3.748 |
| 85 | 7.687 | 6.461 | 5.533 |

### Solubility of Ortho Phthalic Acid in Water, Determined by the Synthetic Method. (Ward and Cooper, 1930.)

| $t^o$ | Gms. o $C_6H_4(COOH)_2$ per 100 gms. sat. sol. | $t^o$ | Gms. o $C_6H_4(COOH)_2$ per 100 gms. sat. sol. | $t^o$ | Gms. o $C_6H_4(COOH)_2$ per 100 gms. sat. sol. |
|---|---|---|---|---|---|
| 25.8 | 0.716 | 63.7 | 2.897 | 101.1 | 15.79 |
| 43.7 | 1.324 | 77.8 | 5.322 | 131.6 | 50.73 |
| 48.9 | 1.647 | 85.7 | 7.594 | 157.5 | 71.57 |
| 58.0 | 2.276 | 94.8 | 11.85 | 193.3 | 100.00 |

Results for equilibrium in the ternary system, ortho phthalic acid, benzoic acid and water are also given.

### Solubility of Phthalic Acid in Aqueous Solutions of Hydrochloric Acid and of Nitric Acid at 25°. (Knox and Richards, 1919.)

In Aq. Hydrochloric Acid.

| Equiv. Normalities. | | Equiv. Normalities. | |
|---|---|---|---|
| HCl | $C_6H_4(COOH)_2$. | HCl | $C_6H_4(COOH)_2$. |
| 0.00 | 0.0852 | 7.603 | 0.0135 |
| 1.729 | 0.0422 | 9.150 | 0.0120 |
| 3.113 | 0.0298 | 10.63 | 0.0128 |
| 4.693 | 0.0216 | 12 05 | 0.0137 |
| 6.100 | 0.0172 | | |

In Aq. Nitric Acid.

| Equiv. Normalities. | | Equiv. Normalities. | |
|---|---|---|---|
| $HNO_3$ | $C_6H_4(COOH)_2$. | $HNO_3$ | $C_6H_4(COOH)_2$. |
| 0.00 | 0.0852 | 10.40 | 0.0325 |
| 2.077 | 0.0582 | 12.60 | 0.0350 |
| 4.077 | 0.0470 | 14.42 | 0.0420 |
| 6.718 | 0.0375 | 15.99 | 0.0577 |
| 9.027 | 0.0331 | | |

### Solubility of Ortho Phthalic Acid in Aqueous Solutions of Salts at 25°. (Herz and Hiebenthal, 1928.)

Results for aqueous solutions of:

Potassium Bromide

| Gms. per liter | |
|---|---|
| KBr | o $C_6H_4(COOH)_2$ |
| 50.0 | 7.0 |
| 63.1 | 6.9 |
| 92.8 | 6.8 |
| 161.9 | 6.0 |
| 238.0 | 5.4 |
| 553.4 | 2.9 |

Potassium Chloride

| Gms. per liter | |
|---|---|
| KCl | o $C_6H_4(COOH)_2$ |
| 22.0 | 7.1 |
| 39.0 | 6.9 |
| 68.0 | 6.3 |
| 144.0 | 5.0 |
| 213.0 | 4.0 |
| 312.0* | 2.8 |

Sodium Chloride

| Gms. per liter | |
|---|---|
| NaCl | o $C_6H_4(COOH)_2$ |
| 0.0 | 7.1 |
| 36.8 | 6.0 |
| 67.8 | 5.0 |
| 122.2 | 3.5 |
| 163.7 | 2.7 |
| 311.6* | 1.0 |

Magnesium Chloride

| Gms. per liter | |
|---|---|
| $MgCl_2$ | o $C_6H_4(COOH)_2$ |
| 0.0 | 7.1 |
| 26.7 | 6.6 |
| 53.3 | 6.0 |
| 147.6 | 4.2 |
| 337.1 | 1.8 |
| 515.2 | 0.8 |

* The salt was present in excess.

Results for equilibrium in the system Phthalic Acid, Sodium Phthalate and water by Smith and Sturm, 1933, are given on p. 1179 of Vol. 1.

· Distribution of Phthalic Acid at 25° Between : (Smith, 1921, 1922.)

Water and Ether.

| Millimols. $C_6H_4(COOH)_2(o)$ per liter of. | | | Water and Xylene. Millimols. $C_6H_4(COOH)_2(o)$ per liter of. | | | Acetone and Glycerol Millimols. $C_6H_4(COOH)_2(o)$ per liter of. | | |
|---|---|---|---|---|---|---|---|---|
| $H_2O$ layer ($C_1$). | $(C_2H_5)_2O$ layer ($C_2$). | $\frac{C_2}{C_1}$. | $H_2O$ layer ($C_1$). | Xylene layer ($C_2$). | $\frac{C_2}{C_1}$. | Acetone layer (A). | Glycerol layer (G). | $\frac{A}{G}$ |
| 0.9687 | 0.6687 | 0.690 | 14.45 | 0.35 | 0.0243 | 0.9375 | 0.8750 | 1.07 |
| 1.5375 | 1.100 | 0.716 | 32.55 | 1.25 | 0.0384 | 1.775 | 1.5875 | 1.12 |
| 2.375 | 1.925 | 0.810 | 38.60 | 1.70 | 0.0430 | 3.800 | 3.200 | 1.19 |
| 3.800 | 3.375 | 0.880 | | | | 8.025 | 6.375 | 1.26 |
| 6.675 | 6.575 | 0.985 | | | | | | |

Distribution of *n* Methyl Piperidine Acid Phthalate and of Piperidine Acid Phthalate Between Acetone and Glycerol at 25°. (Smith, 1921, 1922.)

See note under trimethyl amine acid phthalate on p. 213

Results for Methyl Piperidine Acid Phthalate.

| Millimols. Phthalate per liter of. | | $\frac{A}{G}$. |
|---|---|---|
| Acetone layer (A). | Glycerol layer G. | |
| 0.480 | 1.280 | 0.375 |
| 0.680 | 2.460 | 0.276 |
| 0.90 | 4.55 | 0.198 |
| 1.76 | 12.75 | 0.138 |

Results for Piperidine Acid Phthalate.

| Millimols. Phthalate per liter. | | $\frac{A}{G}$. |
|---|---|---|
| Acetone layer (A). | Glycerol layer G. | |
| 0.250 | 0.356 | 0.702 |
| 0.369 | 0.79 | 0.467 |
| 0.482 | 1.85 | 0.261 |
| 0.700 | 3.86 | 0.181 |
| 1.475 | 10.31 | 0.143 |

100 gms. cymene (b. pt. 176°-176°.5) dissolve 0.024 gm. $C_6H_4(CO\,OH)_2$ (*o*) at 25°. (Wheeler, 1920.)

Distribution of *o* Phthalic Acid and of *m* Phthalic Acid (Isophthalic) between Water and Ether at 25°. (Chandler, 1908.)

Results for *o* Phthalic Acid.

| Mols. *o* $C_6H_4(COOH)_2$ per Liter: | | Ratio $\frac{a}{b}$. | Ratio for Union-ized Acid. |
|---|---|---|---|
| $H_2O$ Layer, *a*. | Ether Layer, *b*. | | |
| 0.0261 | 0.0322 | 0.809 | 0.637 |
| 0.0131 | 0.0150 | 0.873 | 0.645 |
| 0.0085 | 0.0091 | 0.932 | 0.667 |
| 0.0056 | 0.0056 | 1.006 | 0.635 |

Results for *m* Phthalic Acid.

| Mols. *m* $C_6H_4(COOH)_2$ per Liter: | | Ratio $\frac{a}{b}$. | Ratio for Union-ized Acid. |
|---|---|---|---|
| $H_2O$ Layer, *a*. | Ether Layer, *b*. | | |
| 0.000398 | 0.0485 | 0.0821 | 0.0359 |
| 0.000272 | 0.0288 | 0.0943 | 0.0352 |
| 0.000263 | 0.0279 | 0.0944 | 0.0350 |
| 0.000252 | 0.0266 | 0.0949 | 0.0341 |

Ratio of solubilities of Phthalic acids in olive oil and water at 25°. (Böeseken and Waterman, 1911, 1912.)

*o* Phthalic acid, solubility in oil ÷ solubility in $H_2O$ = 0.01.
*p* Phthalic acid (Terephthalic), solubility in oil ÷ solubility in $H_2O$ = 9.52.

100 gms. 95% formic acid dissolve 0.55 gm. *p* phthalic acid (Terephthalic) at 20.2°. (Aschan, 1913.)

Solubility of *o* Phthalic Acid in Alcohol and in Ether at 15°. (Bourgoin, 1878.)

| Solvent. | Gms. $C_6H_4(COOH)_2$ *o* per 100 Gms. | |
|---|---|---|
| | Solution. | Solvent. |
| Absolute Alcohol | 9.156 | 11.70 |
| 90 per cent Alcohol | 10.478 | 10.08 |
| Ether | 0.679 | 0.684 |

Solubility of *o* Phthalic Acid in Alcohols. (Timofeiew, 1894.)

| Alcohol. | t°. | Gms. *o* $C_6H_4(COOH)_2$ per 100 Gms. Sat. Sol. |
|---|---|---|
| Methyl Alcohol | − 2 | 15.1 |
| " " | +19 | 19.5 |
| " " | +21.4 | 20.4 |
| Ethyl Alcohol | − 2 | 8.2 |
| " " | +19 | 11 |
| Ethyl Alcohol | 21.4 | 11.65 |
| Propyl Alcohol | − 3 | 3.42 |
| " " | +19 | 5.27 |
| " " | 22 | 5.54 |
| " " | 23 | 5.70 |

## PHTHALIC ACID

Solubility of Phthalic Acid in Water and in Other Solvents at 28°.
(Desai and Patel, 1935.)

| Solvent | Gm. Mol. $C_6H_4(COOH)_2$ per 1.0 gm. mols. sat. sol. | Solvent | Gm. Mol. $C_6H_4(COOH)_2$ per 1.0 gm. mols. sat. sol. |
|---|---|---|---|
| Water | 0.08724 (=8.04 gm. per 1.) | Chloroform | 0.0184 |
| $CCl_4$ | 0.00244 | Methyl alcohol | 5.125 |
| Benzene | 0.00447 | Ethyl alcohol | 4.265 |
| Toluene | 0.00469 | n Propyl alcohol | 2.732 |
| m-xylene | 0.00465 | n Butyl alcohol | 2.231 |
| Chloro benzene | 0.00577 | Acetone | 2.896 |
| Nitro benzene | 0.00898 | | |

Freezing-point data are given for mixtures of:

Phthalic acid + Benzoic acid (Ward and Cooper, 1930.)
" " + Phthalic anhydride (Monroe, 1919.)

## Sodium PHTHALATES $C_6H_4COOHCOONa$, $C_6H_4(COONa)_2$.

Solubility of Each Separately in Ethyl Alcohol at 23-25°.
(McDermott, 1940.)

| Solvent | Gms. per 100 cc sat. solution | |
|---|---|---|
| | $C_6H_4COOHCOONa$ | $C_6H_4(COONa)_2$ |
| Aq. 72.3 Vol. % $C_2H_5OH$ | — | 2.48 |
| " 79.2 " " " | 2.86 | — |
| " 95.0 " " " | 0.28 | 0.06 |

## METHYL DI NITRO BENZOATE $1,3,5\ (NO_2)_2C_6H_3COOCH_3$.

Freezing-point data for mixtures of methyl and ethyl di nitro benzoates are given by Caldwell and MacLean, 1933.

## INDOL $C_6H_4\langle{}^{CH}_{NH}\rangle CH$.

100 gms. abs. Alcohol dissolve 35.85 gms. $C_8H_7N$ at 20-25° (Pucher and Dehn, 1921.)
" Quinoline " 11.39 " "
" Equi. mol. mixture of alcohol and quinoline dissolve 12.0 gms. $C_8H_7N$ at 20-25°.

Freezing-point data for mixtures of indol and sarcosine anhydride and for mixtures of oxindol and sarcosine anhydride are given by Pfeiffer, Angern and Wang, 1927.

**DIBROM ACETANILIDE** $Br_2C_6H_3NHCOCH_3$.

Freezing-point data are given for mixtures of:

| | | | | |
|---|---|---|---|---|
| 2.4 | dibromoacetanilide | + | 2chloro 4 bromoacetanilide | (Owen, 1923.) |
| 4 | chloro 2 bromoacetanilide | + | " | " |
| 2.4 | dibromoacetanilide | + | 4 chloroacetanilide | " |
| 2 | chloroacetanilide | + | " | (Orion and Owen, 1924.) |
| 1.2.4 | chloronitroacetanilide | + | 1.2.6 chloronitroacetanilide | (de Bruyn, 1917 |
| 1.3.4 | " | + | 1.3.6 " | " |
| 2.4 | dibromoacetanilide | + | p bromoacdtanilide | (Sidgwick, 1915.) |

**DICHLOR ACETANILIDE** 2,4-$Cl_2C_6H_3NHCOCH_3$.

Solubility in Aqueous and in Glacial Acetic Acid.
(Orton and King, 1911.)

| Solvent | $t^o$ | Gms. $C_8H_7ONCl_2$ per 100 gms. sat. sol. |
|---|---|---|
| Aq. 50% acetic acid | 16 | 0.83 |
| Glacial Acetic acid | 16 | 6.37 |

For other results for dibrom and dichlor acetanilides see chloroacetanilides

**α CHLORO ACETOPHENONE** $ClCH_2COC_6H_5$.

Freezing-point data for mixtures of α Chloro aceto phenone and 10, chloro 9, 10, dihydro phenarsazine (Adamsit) are given by Puschin and Hrustanovic, 1938.

**METHYL** Bromo, Chloro and Iodo **BENZOATES.**

Freezing-point data are given by Jaeger, 1906, for mixtures of p $BrC_6H_4COOCH_3$, p $ClC_6H_4COOCH_3$ and p $IC_6H_4COOCH_3$.

**METHYL NITRO BENZOATE** $NO_2C_6H_4COOCH_3$.

Freezing-point data are given for mixtures of methyl and ethyl nitro benzoates by Caldwell and Mac Lean, 1933.

**OXANILIC ACID** $C_6H_5.NH.CO.COOH$.

Solubility of Oxanilic Acid in Aqueous Solutions of

Solubility of Oxanilic Acid in Aqueous Solutions of Acids at 25°.
(Drucker, 1929.)

Results for aqueous solutions of:

| Hydrochloric acid | | Nitric acid | | Sulfuric acid | | Picric acid | |
|---|---|---|---|---|---|---|---|
| Gm. Equiv. per liter | | Gm. Equiv. per liter | | Gm. Equiv. per liter | | Gm. Equiv. per liter | |
| HCl | $C_8H_7O_3N$ | $HNO_3$ | $C_8H_7O_3N$ | $H_2SO_4$ | $C_8H_7O_3N$ | $C_6H_3O_7N_3$ | $C_8H_7O_3N$ |
| 0.002806 | 0.04854 | 0.000 | 0.04990 | 0.00577 | 0.04819 | 0.000 | 0.04990 |
| 0.00608 | 0.04756 | 0.00636 | 0.04711 | 0.01036 | 0.04575 | 0.00417 | 0.04396 |
| 0.01216 | 0.04608 | 0.01437 | 0.04580 | 0.02197 | 0.04557 | 0.00905 | 0.04077 |
| 0.02460 | 0.04458 | 0.05174 | 0.04390 | 0.03758 | 0.04494 | 0.01601 | 0.04026 |
| 0.04773 | 0.04360 | 0.08762 | 0.04353 | 0.1049 | 0.04373 | 0.04336 | 0.05194 |

## DINITRO ACETANILIDE $CH_3CONHC_6H_3(NO_2)_2$.

Freezing-point data for mixtures of Dinitro Acetanilide and p Nitro Acetanilide are given by Holleman and Sluiter, 1906.

## NITROPHENOL ACETATE o $CH_3COOC_6H_4NO_2$.

Freezing-point data for mixtures of o Nitro phenol acetate and o Nitro phenol are given by Boeseken, 1912.

## NITRO METHYL BENZOIC ACIDS $NO_2(CH_3)C_6H_3COOH$.

### Solubility of 6,3 and 2,3 Nitro Methyl Benzoic Acids in Water and Other Solvents.

(Giacalone, 1935.)

Results for $6(NO_2)3(CH_3)C_6H_3COOH$

| t° | Gms. $C_8H_7O_4N$ per 100 gms. $H_2O$ | $C_6H_6$ | $C_6H_5CH_3$ |
|---|---|---|---|
| 0 | — | — | 0.30 |
| 10 | 0.37 | 0.72 | 0.64 |
| 20 | 0.47 | 1.7 (1.4) | 1.20 |
| 30 | 1.7 | 3.5 (2.8) | 2.48 |
| 40 | 1.8 | 8.2 (5.6) | 4.57 |
| 50 | 2.7 | 17.2 (11.2) | 8.63 |
| 60 | 4.5 | 23.1 | 17.1 |
| 70 | 6.6 | 45.2 | 37.7 |
| 80 | 6.7 (100°) | 88.8 | 66.2 |

Results for $2(NO_2)3(CH_3)C_6H_3COOH$

| t° | Gms. $C_8H_7O_4N$ per 100 gms. $H_2O$ | $C_6H_6$ |
|---|---|---|
| 20 | 0.04 | 0.032 |
| 40 | 0.16 | 0.22 |
| 60 | 0.42 | 0.41 |
| 80 | 0.58 | 0.45 |
| 100 | 0.6 | — |

The results in parentheses are calculated from the curve.

Freezing-point data for mixtures of p Nitro benzoic acid methyl ester and p Nitro benzoic acid ethyl ester are given by Caldwell and Mac Lean, 1933.

Brom **ACETANILIDE** $BrC_6H_4NHCOCH_3(p)$.

Freezing-point data for mixtures of Brom acetanilide and dibrom acetanilide are given by Sidgwick, 1915.

Freezing-point data for mixtures of aceto-2-chloranilide and aceto-4-chlor anilide are given by Orton and Owen, 1924.

Chlor**ACETANILIDES**, $Cl.C_6H_4NH.COCH_3$ *o*, *m* and *p*.

Solubility of Each in Water (Sidgwick and Ruhie, 1924.)

Note. — The determinations were made by the synthetic method. Sealed bulbs of 2 or 3 cc. capacity were used at the higher temperatures and a Beckmann apparatus at the lower temperatures. Those points at which the solid phase separated are marked with an asterisk, the others show the composition of one of the two liquid layers which are formed. The triple point was determined in all cases but not the critical temperature of the liquid layers.

| Ortho Chloracetanilide. | | Meta Chloracetanilide. | | Para Chloracetanilide. | |
|---|---|---|---|---|---|
| t°. | Gms. $Cl.C_6H_4NH.COCH_3$ per 100 gms. sat. sol. | t°. | Gms. $Cl.C_6H_4NH.COCH_3$ per 100 gms. sat. sol. | t°. | Gms. $Cl.C_6H_4NH.COCH_3$ per 100 gms. sat. sol. |
| 86.7.... | 100.0* | 76.6.... | 100.0* | 178.4.... | 100.0* |
| 77.0.... | 97.4* | 69.0.... | 98.0* | 168.0.... | 97.38* |
| 70.0.... | 95.0* tr.pt. | 64.0.... | 96.82* | 150.0.... | 93.16* |
| 105.0.... | 92.87 | 59.5.... | 95.0* tr.pt. | 138.0.... | 90.0* tr.pt. |
| 150.0.... | 88.72 | 81.0.... | 94.41 | 142.0.... | 89.6 |
| 175.0.... | 85.12 | 123.0.... | 91.29 | 160.0.... | 88.08 |
| 182.0.... | 10.21 | 165.0.... | 86.86 | 178.0.... | 85.23 |
| 155..... | 6.63 | 176..... | 6.14 | 169.0.... | 3.85 |
| 142..... | 5.13 | 138..... | 2.76 | 140..... | 1.87* |
| 105..... | 2.94 | 130..... | 2.49 | 115..... | 0.837* |
| 65..... | 0.692* | 76..... | 0.743 | 97..... | 0.384* |
| 15..... | 0.323* | | | 65.5.... | 0.095* |

Solubility of Halogen Substituted Acetanilides in Ethyl Alcohol at Different Temperatures. (Chattaway and Lambert, 1915.)

| | Gms. of Each Anilide per 100 Gms. of Each Sat. Solution. | | | | | |
|---|---|---|---|---|---|---|
| t°. | *p* Chloro-acetanilide. | 2.4 Dichloro-acetanilide. | *p* Bromo-acetanilide. | 2.4 Dibromo-acetanilide. | 4 Chloro-2 Bromo-acetanilide. | 2 Chloro-4 Bromo-acetanilide. |
| 5 | ..... | ..... | 4.244 | 2.480 | ... | ... |
| 10 | 3.278 | 3.008 | 4.847 | 2.876 | 4.334 | 2.575 |
| 15 | 3.777 | 3.564 | 5.561 | 3.382 | 5.088 | 2.961 |
| 20 | 4.366 | 4.192 | 6.390 | 4.002 | 5.986 | 3.466 |
| 25 | 5.040 | 4.962 | 7.300 | 4.714 | 7.043 | 4.095 |
| 30 | 5.828 | 5.864 | 8.440 | 5.615 | 8.328 | 4.891 |
| 35 | 6.700 | 6.937 | 9.715 | 6.686 | 9.844 | 5.820 |
| 40 | 7.728 | 8.276 | 11.156 | 7.914 | 11.586 | 6.887 |
| 45 | 8.918 | 9.750 | 12.767 | 9.357 | 13.718 | 8.186 |

(Results for unstable needle forms of *p* bromoacetanilide and 2.4 dibromo-acetanilide are also given.)

### Solubility of Ortho, Meta and Para Chloroacetanilides in Benzene.

(Sidgwick and Rubie, 1921.)

The synthetic method was used. A solid phase separated in each case.

| Ortho Chloroacetanilide | | Meta Chloroacetanilide. | | Para Chloroacetanilide. | |
|---|---|---|---|---|---|
| t°. | Gms. $Cl.C_6H_4NH.COCH_3$ per 100 gms. sat. sol. | t°. | Gms. $Cl.C_6H_4NH.COCH_3$ per 100 gms. sat. sol. | t°. | Gms. $Cl.C_6H_4NH.COCH_3$ per 100 gms. sat. sol. |
| 84.8.. .. | 97.45 | 76.6.... | 100.0 | 178.4..... | 100.0 |
| 80.0..... | 92.16 | 70.0.... | 92.74 | 172.0..... | 93.62 |
| 69.5..... | 79.53 | 61.0.... | 81.20 | 162.0. ... | 78.50 |
| 61.4. ... | 68.22 | 51.5.... | 68.17 | 154.5..... | 69.67 |
| 50.5..... | 52.06 | 46.0.... | 59.51 | 144.2..... | 55.86 |
| 45.2..... | 41.69 | 39.5.... | 47.31 | 134.5..... | 37.80 |
| 37.8..... | 30.65 | 29.2.... | 32.81 | 125.2..... | 21.14 |
| 31.4..... | 21.77 | 15.4.... | 20.04 | 122.4..... | 18.16 |
| 20.2..... | 13.50 | | | 107.5..... | 6.63 |
| 10.0..... | 9.56 | | | 96.5..... | 4.21 |

100 cc. of water dissolve approx. 1.33 gms. *o* chloro, *o* nitroacetanilide at ord. temp.

» » 1.11 » *o* » *p* »

100 cc. of dil. acid* » 1.55 » *o* » *o* »

» » 1.55 » *o* » *p* »

* The dilute acid contained 14.4 cc. $HNO_3$ and 7.7 cc. $CH_3COOH$ per 100 cc. (Franzel and Engel, 1921.)

## N-CHLORO ACETANILIDE $CH_3CO.NCl.C_6H_5$.

### Solubility of N-Chloro Acetanilide in Aqueous Acid and Salt Solutions at 25°.

(Soper and Pryde, 1927.)

An excess of the N-chloro acetanilide was shaken with the aqueous solvent for 15 minutes and 10 cc of the sat. solution titrated for chloro amine by adding to acidified KI and titrating the liberated iodine with thio sulfate.

| Ionic strength of Acid or Salt solution | Gm. Mols. $C_8H_8ONCl$ per liter in Aq. | | | |
|---|---|---|---|---|
| | HCl | $HNO_3$ | KCl | $KNO_3$ |
| 0.0 | 0.01383 | 0.01383 | 0.01383 | 0.01383 |
| 0.1 | 0.01398 | 0.01418 | 0.01323 | 0.01350 |
| 0.4 | 0.01434 | 0.01511 | 0.01232 | 0.01275 |
| 0.7 | 0.01461 | 0.01680 | 0.01105 | 0.01275 |
| 1.0 | 0.01495 | 0.01935 | 0.00963 | 0.01243 |
| 1.5 | 0.1577 | 0.02295 | 0.00880 | 0.01178 |

## Phenyl**ACETIC ACID** (α Toluic Acid) $CH_2(C_6H_5)COOH$.

### Solubility in Water and in Alcohols. (Timofeiew, 1894.)

| Solvent. | t°. | Gms. $CH_2(C_6H_5)COOH$ per 100 Gms. Sat. Sol. | Solvent. | t°. | Gms. $CH_2(C_6H_5)COOH$ per 100 Gms. Sat. Sol. |
|---|---|---|---|---|---|
| Water | 20 | 1.64 | Ethyl Alcohol | 0.0 | 50.7 |
| Methyl Alcohol | −17 | 50.6 | " | +19.4 | 64.4 |
| " | −13 | 53.2 | " | 20.0 | 65.1 |
| " | 0 | 59.2 | Propyl Alcohol | −17.0 | 29.4 |
| " | +19.4 | 70.8 | " | −13.0 | 32.3 |
| " | 20 | 71.8 | " | 0.0 | 40.9 |
| Ethyl Alcohol | −17 | 39.7 | " | +19.4 | 56.8 |
| " | −13 | 41.5 | " | 20.0 | 57.2 |

One liter sat. solution of Phenyl acetic acid in water contain 17.3 gms. $CH_2(C_6H_5)COOH$ at 25°. (Reyer, 1923.)

## Phenyl**ACETIC ACID** ($\alpha$ Toluic Acid) $CH_2(C_6H_5)COOH$.

### Solubility in Water and in Benzene, Determined by the Synthetic Method.

(Sidgwick and Ewbank, 1921 *a*.)

| In Water. | | | In Benzene. | | |
|---|---|---|---|---|---|
| t° | Gms. $CH_2(C_6H_5)COOH$ per 100 gms. sat. sol. | Solid Phase. | t°. | Gms. $CH_2(C_6H_5)COOH$ per 100 gms. sat. sol. | Solid Phase. |
| 76.7..... | 100.0 | $CH_2(C_6H_5)COOH$ | 59.0..... | 81.03 | $CH_2(C_6H_5)COOH$ |
| 48.5..... | 80.96 | » | 42.0..... | 61.28 | » |
| 45.5 tr. pt. | – | » + liquid layer | 29.0..... | 42.98 | » |
| 94.8..... | 61.94 | liquid layers | 13.0..... | 28.00 | » |
| 106.8..... | 39.69 | » | 3.0..... | 19.93 | » |
| 108.0 crit. t. | – | » | 2.2..... | 16.30 | $C_6H_6$ |
| 108.0..... | 20.0 | » | 3.2..... | 13.04 | » |
| 84.7..... | 5.65 | » | 4.6..... | 6.22 | » |

### Solubility of Phenyacetic Acid and of Diphenylacetic Acid in Aqueous Solutions of Hydrochloric Acid at 25°. (Knox and Richards, 1919.)

| Results for Phenylacetic Acid. | | | | Results for Diphenylacetic Acid. | | | |
|---|---|---|---|---|---|---|---|
| Gm. mols. per liter | | Gms. mols. per liter. | | Gm. mols. per liter. | | Gm. mols. per liter. | |
| HCl. | $CH_2(C_6H_5)$ .COOH. | HCl. | $CH_2(C_6H_5)$ .COOH. | HCl | $CH(C_6H_5)_2$ .COOH. | HCl. | $CH(C_6H_5)_2$ COOH. |
| 0.0 | 0.01310 | 7.175 | 0.0756 | 0.0 | 0.00060 | 7.349 | 0.00041 |
| 1.417 | 0.0984 | 8.580 | 0.0815 | 1.620 | 0.00047 | 8.889 | 0.00042 |
| 2.890 | 0.0833 | 9.988 | 0.0916 | 2.913 | 0.00040 | 10.27 | 0.00046 |
| 4.313 | 0.0763 | 11.36 | 0.1099 | 4.512 | 0.00036 | 11.74 | 0.00053 |
| 5.770 | 0.0739 | | | 5.972 | 0.00038 | | |

### Solubility of Phenyl Acetic Acid in Aqueous Solutions of Sulfuric Acid at 25°.

(Hammett and Chapman, 1934.)

| Wt. % $H_2SO_4$ in aqueous solvent | Gm. Mols. $C_8H_8O_2$ per 1000 gms. solvent | Wt. % $H_2SO_4$ in aqueous solvent | Gm. Mols. $C_8H_8O_2$ per 1000 gms. solvent | Wt. % $H_2SO_4$ in aqueous solvent | Gm. Mols. $C_8H_8O_2$ per 1000 gms. solvent |
|---|---|---|---|---|---|
| 0.0 | 0.1267 (=17.24 gms.) | 48.89 | 0.0259 | 68.03 | 0.0431 |
| 11.28 | 0.0801 | 50.55 | 0.0258 | 70.27 | 0.0530 |
| 28.51 | 0.0330 | 52.76 | 0.0275 | 72.46 | 0.0630 |
| 37.61 | 0.0283 | 58.67 | 0.0287 | 74.54 | 0.0904 |
| 46.74 | 0.0260 | 64.30 | 0.0343 | 77.40 | 0.1947 |

### Distribution of Phenylacetic Acid at 25° Between : (Smith, 1921-1922.)

Water and Chloroform.

| Millimols. $CH_2(C_6H_5)COOH$ per liter of : | | |
|---|---|---|
| $H_2O$ layer ($C_1$). | $CHCl_3$ layer ($C_2$). | $\frac{C_2}{C_1}$. |
| 0.280 | 0.475 | 1.70 |
| 0.425 | 0.785 | 1.845 |
| 0.518 | 1.010 | 1.95 |
| 0.715 | 1.542 | 2.16 |

Water and Ether.

| Millimols. $CH_2(C_6H_5)COOH$ per liter of : | | |
|---|---|---|
| $H_2O$ layer ($C_1$). | $(C_2H_5)_2O$ layer ($C_2$). | $\frac{C_2}{C_1}$. |
| 0.085 | 1.255 | 14.7 |
| 0.17 | 2.47 | 14.5 |
| 0.26 | 3.82 | 14.7 |
| 0.44 | 7.44 | 16.9 |
| 1.08 | 16.12 | 15.0 |

## Distribution of Phenylacetic Acid Between Water and Xylene at 25°.

(Smith, 1921-1922.)

Results using :

| 1 vol. $H_2O$ to 1 vol. Xylene. Millimols. $CH_2(C_6H_5)COOH$ per liter of | | | 1 vol. $H_2O$ to 2 vols Xylene. Millimols. $CH_2C_6H_5COOH$ per liter of | | | 2 vols. $H_2O$ to 1 vol. Xylene. Millimols. $CH_2(C_6H_5)COOH$ per liter of | | |
|---|---|---|---|---|---|---|---|---|
| $H_2O$ layer ($C_1$). | Xylene layer ($C_2$). | $\frac{C_2}{C_1}$. | $H_2O$ layer ($C_1$). | Xylene layer ($C_2$). | $\frac{C_2}{C_1}$. | $H_2O$ layer ($C_1$). | Xylene layer ($C_2$). | $\frac{C_2}{C_1}$. |
| 1.26 | 0.5750 | 0.456 | 1.400 | 1.275 | 0.910 | 1.18 | 0.175 | 0.148 |
| 1.60 | 0.7750 | 0.484 | 2.250 | 2.400 | 1.068 | 1.75 | 0.35 | 0.200 |
| 2.60 | 1.5375 | 0.592 | 2.875 | 3 325 | 1.16 | 2.58 | 0.85 | 0.330 |
| 3.50 | 2.473 | 0.708 | 3.575 | 4.825 | 1.35 | 4.90 | 3.05 | 0.623 |
| 5.00 | 5.00 | 1.00 | | | | | | |

## Distribution of Phenyl Acetic Acid at 25° Between Water and:

(Kolossowski, Kulikow and Bekturow, 1933; Kolossowski and Bekturow, 1935.)

| Nitro benzene $C_6H_5NO_2$ | | | Toluene $C_6H_5CH_3$ | | | Iso Amyl Alcohol $(CH_3)_2CHCH_2CH_2OH$ | | |
|---|---|---|---|---|---|---|---|---|
| Gm. Mols. $C_8H_8O_2$ per liter | | $\frac{1}{2}$ | Gm. Mols. $C_8H_8O_2$ per liter | | $\frac{1}{2}$ | Gm. Mols. $C_8H_8O_2$ per liter | | $\frac{1}{2}$ |
| $H_2O$ layer (1) | $C_6H_5NO_2$ layer (2) | | $H_2O$ layer (1) | $C_6H_5CH_3$ layer (2) | | $H_2O$ layer (1) | $C_5H_{11}OH$ layer (2) | |
| 0.0067 | 0.0335 | 0.200 | 0.012 | 0.032 | 0.375 | 0.0039 | 0.016 | 0.246 |
| 0.0105 | 0.069 | 0.152 | 0.017 | 0.051 | 0.353 | 0.0071 | 0.059 | 0.120 |
| 0.0267 | 0.267 | 0.100 | 0.020 | 0.063 | 0.317 | 0.0070 | 0.137 | 0.051 |
| 0.043 | 0.564 | 0.0760 | 0.027 | 0.111 | 0.243 | 0.0099 | 0.221 | 0.045 |
| 0.053 | 0.785 | 0.0675 | 0.063 | 0.551 | 0.114 | 0.011 | 0.267 | 0.041 |
| 0.061 | 1.060 | 0.057 | 0.067 | 0.700 | 0.096 | 0.015 | 0.404 | 0.031 |
| 0.068 | 1.262 | 0.054 | 0.079 | 0.996 | 0.079 | 0.016 | 0.457 | 0.035 |
| 0.076 | 1.571 | 0.048 | 0.091 | 1.168 | 0.078 | 0.029 | 0.808 | 0.036 |
| 0.084 | 1.899 | 0.044 | 0.103 | 1.340 | 0.077 | 0.038 | 1.052 | 0.036 |
| 0.091 | 2.249 | 0.040 | 0.130 | 1.960 | 0.066 | 0.051 | 1.372 | 0.037 |
| 0.096 | 2.470 | 0.039 | 0.130 | 2.135 | 0.061 | 0.066 | 1.818 | 0.033 |
| 0.107 | 2.783 | 0.038 | | | | 0.069 | 2.059 | 0.033 |

## Distribution of Phenyl Acetic Acid at 25° Between Water and:

(Smith and White, 1929.)

| Chloroform | | Benzene | | Toluene | |
|---|---|---|---|---|---|
| Gm. Mols. $C_8H_8O_2$ per liter | | Gm. Mols. $C_8H_8O_2$ per liter | | Gm. Mols. $C_6H_8O_2$ per liter | |
| $H_2O$ layer | $CHCl_3$ layer | $H_2O$ layer | $C_6H_6$ layer | $H_2O$ layer | $C_6H_5CH_3$ layer |
| 0.00148 | 0.0050 | 0.0043 | 0.00761 | 0.00509 | 0.00381 |
| 0.00194 | 0.00735 | 0.0058 | 0.01233 | 0.01139 | 0.02591 |
| 0.00237 | 0.00994 | 0.00732 | 0.01812 | 0.01349 | 0.03435 |
| 0.00389 | 0.0213 | 0.00935 | 0.02795 | 0.01667 | 0.05089 |
| 0.00572 | 0.0412 | 0.01102 | 0.03682 | 0.01990 | 0.07080 |
| 0.00796 | 0.0739 | 0.01364 | 0.05992 | | |
| 0.01010 | 0.1089 | 0.01626 | 0.07454 | | |

### Solubility of Phenylacetic Acid in Several Solvents at 25°.

(Herz and Rathmann, 1913.)

| Solvent. | Gms. $CH_2(C_6H_5)COOH$ per 100 cc. Sat. Sol. | Solvent. | Gms. $CH_2(C_6H_5)COOH$ per 100 cc. Sat. Sol. |
|---|---|---|---|
| Chloroform | 60.17 | Tetrachlorethylene | 21.19 |
| Carbon Tetrachloride | 25.07 | Tetrachlorethane | 61.45 |
| Trichlorethylene | 44.89 | Pentachlorethane | 44.26 |

### Critical Solution Temperatures of Mixtures of Phenyl Acetic Acid and Other Compounds.

(Lecat, 1929.)

Mixtures of Phenyl Acetic Acid and:

| | Crit. sol. temp. | | Crit. sol. temp. |
|---|---|---|---|
| Acenaphthene | 62.8 | Di phenyl | 61.0 |
| iso Amyl benzoate | 30.0 | Di phenyl methane | 40.6 |
| iso Amyl oxalate | 46.0 | iso Eugenol methyl ether | 48.5 |
| α Bromo naphthalene | 55.3 | Phenyl ether | 30.6 |
| α Chloro naphthalene | 36.0 | | |

Freezing-point data are given for mixtures of phenyl acetic acid and:

Benzyl phenyl acetate(1)
Chlor acetic acid(5)
Di anisol acetone(3)
Di benzyl acetone(3)
Di chlor acetic acid(5)
Di methyl pyrone(6)
Ethyl phenyl acetate(1)
Hydro cinnamic acid(4)
Lithium phenyl acetate(1)
Methyl phenyl acetate(1)
Michler's ketone(3)
Picric acid(8)
Sulfuric acid (7)
Tetra methyl phthalan(2)
Tetra methyl di amino benzo phenone(9)
Tri chlor acetic acid(5)

Also for mixtures of Ethyl phenyl acetate + Sodium phenyl acetate(1)

(1) Bakunin and Vitale, 1935; (2) Bennett and Wain, 1936; (3) Pfeiffer, 1924; (4) Salkowski, 1885; (5) Kendall, 1914; (6) Kendall, 1924a; (7) Kendall and Carpenter, (8) Kendall, 1916; (9) Pfeiffer, Goebel and Angern, 1925.

### Hydroxy TOLUALDEHYDES $C_6H_3.CHO.OH.CH_3$, 1, 2, 5; 1, 4, 5 and 1, 4. 6.

Solubility of Each Separately in Water. (Sidgwick and Allott, 1923.)

The determinations were made by the synthetic, sealed tube, method. The concentrations are in terms of wt. %, that is, grams of each compound per 100 gms. sat. solution. The points at which a second liquid layer separated are marked L. The unstable points are marked with an asterisk.

Results for $C_6H_3.(1)CHO.(2)OH.(5)CH_3$.

| t°. | Wt. %. |
|---|---|
| 99.1 | 2.52 L |
| 156.5 | 5.47 L |
| 137.1 | 92.73 L |
| 87.7 | 96.09 L |
| 55.1 | 100.00 |

Results for $C_6H_3.(1)CHO.(4)OH.(5)CH_3$.

| t°. | Wt. %. | t°. | Wt. % |
|---|---|---|---|
| 67.3 | 1.69 | 87.2 | 56.0 L |
| 55.9 | 1.69 L* | 79.5[b] | 56.0 |
| 99.3 | 5.45 L | 79.6 | 59.9 |
| 127.0 | 16.5 L | 80.3 | 73.3 |
| 133.5 | 23.5 L | 91.2 | 86.8 |
| 136.8[a] | 35.4 L | 117.4 | 100.0 |
| 127.0 | 52.5 L | | |

[a] Crit. t. [b] Tr. pt.

Results for $C_6H_3.(1)CHO.(4)OH.(6)CH_3$.

| t° | Wt. %. | t°. | Wt.%: |
|---|---|---|---|
| 56.8 | 5.78 | 69.1[b] | 50.6 |
| 85.8 | 7.95 L | 69.2 | 51.0 |
| 116.3 | 14.3 L | 69.4 | 59.5 |
| 125.0[a] | 34.0 L | 69.9 | 69.5 |
| 124.5 | 44.6 L | 75.9 | 82.7 |
| 121.1 | 48.5 L | 108.9 | 100.0 |
| 78.8 | 50.3 L | | |

SOLUBILITY OF HYDROXY TOLUALDEHYDES, EACH SEPARATELY, IN BENZENE.
(Sidgwick and Allott, 1923.)

Results for $C_6H_3.(1)CHO.(2)OH.(5)CH_3$.

| t°. | Wt. %. | |
|---|---|---|
| 5.32..... | 0.0 | B |
| 3.45..... | 5.56 | B |
| 1.30..... | 11.50 | B |
| −0.60..... | 17.0 | B |
| −2.40..... | 21.5 | B |
| −3.0 Eutec.. | 23.3 | |
| +0.15..... | 27.4 | |
| 6.05..... | 34.0 | |
| 11.5..... | 41.7 | |
| 21.6..... | 55.4 | |
| 28.0..... | 64.4 | |
| 31.8..... | 71.0 | |
| 46.0..... | 90.9 | |

Results for $C_6H_3.(1)CHO.(4)OH.(5)CH_3$.

| t°. | Wt. %. |
|---|---|
| 37.2..... | 2.27 |
| 66.7..... | 7.08 |
| 72.4..... | 11.7 |
| 76.0..... | 18.8 |
| 79.8..... | 26.9 |
| 83.7..... | 38.6 |
| 85.8..... | 48.4 |
| 92.1..... | 63.0 |
| 98.2..... | 73.9 |
| 117.4..... | 100.0 |

Result for $C_6H_3.(1)CHO.(4)OH.(6)CH_3$.

| t°. | Wt. %. |
|---|---|
| 54.7..... | 4.94 |
| 67.5..... | 8.19 |
| 72.9..... | 17.5 |
| 75.7..... | 33.2 |
| 81.8..... | 53.3 |
| 86.7..... | 67.5 |
| 89.1..... | 71.5 |
| 108.9..... | 100.0 |

B indicates that solid benzene separated.

**XYLOQUINONE** (*p*) (Phlorone) $C_6H_2O_2(CH_3)_2$.

100 gms. abs. alcohol dissolve 1.12 gms. $C_6H_2O_2(CH_3)_2$ at 20°–25°.
» quinoline » 3.02 » »
» equi. mol. mixture of alcohol and quinoline dissolve 4.69 gms. $C_6H_2O_2(CH_3)_2$ at 20°–25°. (Pucher and Dehn, 1921.)

**METHYL BENZOATE** $C_6H_5COOCH_3$.

EQUILIBRIUM IN THE SYSTEM METHYL BENZOATE, METHYL ALCOHOL AND WATER.
(Gilbert and Lauer, 1927.)

Results at 15°

| Gms. per 100 gms. sat. sol. | |
|---|---|
| $CH_3OH$ | $C_8H_8O_2$ |
| 0.0 | 0.1 |
| 52.0 | 10.7 |
| 52.4 | 14.5 |
| 52.6 | 17.3 |
| 50.6 | 23.1 |
| 47.4 | 29.9 |
| 45.1 | 34.5 |
| 39.3 | 44.0 |
| 29.3 | 60.0 |
| 19.4 | 75.0 |
| 16.1 | 79.4 |
| 0.0 | 99.8 |

Results at 25°

| Gms. per 100 gms. sat. sol. | |
|---|---|
| $CH_3OH$ | $C_8H_8O_2$ |
| 0.0 | 0.4 |
| 39.9 | 1.1 |
| 43.6 | 2.2 |
| 46.5 | 4.4 |
| 50.3 | 9.5 |
| 50.6 | 11.7 |
| 50.6 | 14.0 |
| 49.8 | 17.8 |
| 48.0 | 23.9 |
| 45.4 | 30.0 |
| 39.4 | 41.3 |
| 31.7 | 54.4 |
| 24.5 | 65.8 |
| 19.2 | 74.1 |
| 12.4 | 83.8 |
| 0.0 | 99.4 |

Results at 35°

| Gms. per 100 gms. sat. sol. | |
|---|---|
| $CH_3OH$ | $C_8H_8O_2$ |
| 0.0 | 0.5 |
| 47.0 | 8.9 |
| 48.3 | 11.3 |
| 49.2 | 15.2 |
| 48.6 | 18.0 |
| 47.8 | 21.7 |
| 44.9 | 28.0 |
| 42.7 | 32.7 |
| 39.1 | 39.8 |
| 35.7 | 45.8 |
| 32.3 | 51.7 |
| 26.9 | 59.9 |
| 25.0 | 62.4 |
| 20.9 | 68.3 |
| 0.0 | 98.8 |

Freezing-point data for mixtures of methyl benzoate and tri chloro acetic acid are given by Kendall and Booge, 1916.

## TOLUIC ACIDS (Monomethyl Benzoic Acids) $CH_3.C_6H_4COOH$.

### Solubility of Toluic (Methyl Benzoic) Acids in Water at 25°.

| | (Paul, 1894.) | | (Vaubel, 1895.) | (Führer, 1924.) |
|---|---|---|---|---|
| | $C H_3C_6H_4COOH$ per liter | | Gms. $CH_3C_6H_4COOH$ | Gms. $CH_3C_6H_4COOH$ |
| | Gms. | Gm. Mols. | per 1000 gms. sat. sol. | per 1000 gms. $H_2O$ |
| Ortho-Toluic Acid | 1.182 | 0.008683 | 1.18 | 1.183 |
| Meta " " | 0.980 | 0.007207 | 0.98 | 0.981 |
| Para " " | 0.345 | 0.002540 | 0.35 | 0.345 |

One liter sat. solution in water contains 0.42 gram *p* toluic acid at 25°. One liter sat. solution in 1 *n* aq. sodium *p* toluate contains 0.735 gm. *p* toluic acid at 25°. (Sidgwick, 1910.)

### Solubility of Toluic Acids (Each Separately) in Water at Various Temperatures.

(Sidgwick, Spurrell and Davies, 1915.)

The determinations were made by the synthetic method, see p. 16; melting-point of *o* toluic acid = 102.4°, of *m* acid = 110.5° and of *p* acid = 176.8°. The triple point (solid phase present) for the *o* acid, is at 93.5° and the concentration of acid in the two layers is 2.5 and 91.2 gms. respectively per 100 gms. sat. solution. The tr. pt. for the *m* acid is at 91.8° and concentrations are 1.6 and 90.5; the tr.-pt. for the *p* acid is at 142° and concentrations, 5 and 74.

| t°. | Gms. per 100 Gms. Sat. Sol. *o* Toluic Acid. | *m* Toluic Acid. | *p* Toluic Acid. | t°. | Gms. per 100 Gms. Sat. Sol. *o* Toluic Acid. | *m* Toluic Acid. | *p* Toluic Acid. |
|---|---|---|---|---|---|---|---|
| 80 | 2.03* | 1.16* | ... | 140 | 9.25 | 5.77 | 4.30* |
| 90 | 2.42* | 1.54 | ... | 150 | 13.7 | 8.40 | 9.33 |
| 100 | 2.97 | 1.98 | 1.16* | 159.1 crit t. | ... | ... | ∞ |
| 110 | 3.71 | 2.52 | 1.36* | 160 | 30 | 19.4 | |
| 120 | 5.10 | 3.24 | 1.75* | 161.1 crit. t. | ∞ | ... | |
| 130 | 6.93 | 4.30 | 2.50* | 162.2 crit. t. | ... | ∞ | |

* Indicates that a solid phase is present.

Additional data for the solubility of the above compounds in water, determined by the synthetic method, are given by Flaschner and Rankin (1910).

### Solubility of Meta Toluic Acid in Aqueous Solutions of Magnesium Sulfate at 25°.

(Randall and Failey, 1927.)

| Ionic Strength of $MgSO_4$ in Aq. Solvent | Gm. Mols. in $CH_3C_6H_4COOH$ per liter sat. sol. | Ionic Strength of $MgSO_4$ in Aq. solvent | Gm. Mols. in $CH_3C_6H_4COOH$ per liter sat. sol. |
|---|---|---|---|
| 0.0 (= $H_2O$) | 0.008783 | 0.2000 | 0.009126 |
| 0.04792 | 0.009044 | 0.6400 | 0.009015 |
| 0.1000 | 0.009124 | 0.9836 | 0.008653 |

### Distribution of Ortho Toluic Acid at 25° Between:

(Smith and White, 1929.)

Water and Chloroform

| Gm. Mols. $C_8H_8O_2$ per liter | |
|---|---|
| $H_2O$ layer | $CHCl_3$ layer |
| 0.00211 | 0.1123 |
| 0.00257 | 0.1470 |
| 0.00290 | 0.1700 |
| 0.00370 | 0.2330 |
| 0.00449 | 0.3100 |

Water and Toluene

| Gm. Mols. $C_8H_8O_2$ per liter | |
|---|---|
| $H_2O$ layer | $C_6H_5CH_3$ layer |
| 0.00257 | 0.0565 |
| 0.00277 | 0.0640 |
| 0.00304 | 0.0748 |
| 0.00330 | 0.0870 |
| 0.00356 | 0.0990 |

### Distribution of Para Toluic Acid at 25° Between:

(Smith and White, 1929.)

Water and Chloroform'

| Gm. Mols. $C_8H_8O_2$ per liter | |
|---|---|
| $H_2O$ layer | $CHCl_3$ layer |
| 0.00070 | 0.0418 |
| 0.00084 | 0.0547 |
| 0.00098 | 0.0641 |
| 0.00119 | 0.0871 |
| 0.00132 | 0.1008 |

Water and Toluene

| Gm. Mols. $C_8H_8O_2$ per liter | |
|---|---|
| $H_2O$ layer | $C_6H_5CH_3$ layer |
| 0.00145 | 0.0255 |
| 0.00159 | 0.0301 |
| 0.00172 | 0.0355 |
| 0.00185 | 0.0405 |
| 0.00198 | 0.0466 |
| 0.00211 | 0.0528 |

### Ratio of the Solubilities of Toluic Acids (Separately Determined) in Water and in Olive Oil at 25°.

(Boeseken and Waterman, 1911, 1912.)

The solubilities of each acid in water and in olive oil was separately determined and the ratio considered to correspond to the distribution coefficients in each case. The concentrations of the dissolved acids are not given.

| Acid. | Ratio of $\frac{\text{Solubility in Olive Oil}}{\text{Solubility in Water}}$. |
|---|---|
| *o* Toluic Acid | 40.5 |
| *m* " " | 21 |
| *p* " " | 29.5 |

100 gms. 95% formic acid dissolve 2.99 gms. *o* toluic acid at 20.8°. (Aschan, 1913.)

### Solubility of Ortho, Meta and Para Toluic Acids ($C_6H_4.CH_3.CO\,OH$), Each Separately, in Ortho, Meta and Para Xylene, at 14°.

(Chapas, 1922.)

Each solvent was saturated with the given acid at the temperature of the water bath and the mixture allowed to cool to room temperature, while being agitated from time to time. The dissolved acid was determined by agitating a weighed amount of the saturated solution with an excess of 0.1 *n* Na OH and titrating with 0.1 *n* H Cl, using phenolphthalein as indicator.

| Compound. | Formula. | Gms. compound dissolved per 100 gms. | | |
|---|---|---|---|---|
| | | *o* Xylene. | *m* Xylene. | *p* Xylene. |
| Ortho toluic acid..... | $C_6H_4.CH_3.COOH$ (*o*) | 7.11 | 5.78 | 7.39 |
| Meta " ..... | " (*m*) | 8.63 | 8.57 | 10.32 |
| Para " ..... | " (*p*) | 1.05 | 0.91 | 1.47 |

### Solubility of Ortho, Meta and Para Toluic Acids, Each Separately, in Chloro Benzene and Toluenes.

(Chapas, 1930.)

| Solvent | t° | Per 100 gm. mols. sat. solution: Gm. Mols. o Toluic acid | Gm. Mols. m Toluic acid | Gm. Mols. p Toluic acid |
|---|---|---|---|---|
| Chloro Benzene | 0 | 3.12 | 3.97 | — |
| " " | 14.1 | 6.19 | 7.08 | — |
| " " | 31.8 | 12.73 | 14.07 | 1.76 |
| o Chloro Toluene | 0 | 3.16 | 3.95 | — |
| " " | 14.2 | 6.24 | 6.88 | — |
| " " | 31.9 | 13.40 | 13.61 | 1.70 |
| p Chloro Toluene | 0 | — | — | — |
| " " | 14.1 | 6.15 | 7.05 | 0.81 |
| " " | 31.8 | 13.1 | 13.72 | 1.74 |

Freezing-point data are given for mixtures of Toluic Acids and:

Acetyl di phenyl(7)
Azo benzene(7)
Benzoic acid(2)
Chlor acetic acid(2)
Di chlor acetic acid(2)
Di methyl pyrone(3)
Iodo benzoic acid(6)
Methoxy anthra quinone(7)
Picric acid(4)
Sarcosine anhydride(7)
Sulfuric acid(5)
Tetra methyl phthalan(1)
Tri chlor acetic acid(2)

(1) Bennett and Wain, 1936; (2) Kendall, 1914; (3) Kendall, 1914a; (4) Kendall, 1916; (5) Kendall and Carpenter, 1914; (6) Lettre and Lehmann, 1938; (7) Pfeiffer, Angern, Wang, Seydel and Quehl, 1930.

**ANISALDEHYDE** $CH_3OC_6H_4CHO$.

100 gms. sat. solution of anisaldehyde in liquid ammonia contain about 70 gms. $CH_3OC_6H_4CHO$ at ? t°. (De Carli, 1927.)

Freezing-point data for mixtures of anisaldehyde and tri chlor acetic acid are given by Kendall and Gibbons, 1915.

**ANILINE TRI CHLOR ACETATE** $C_6H_5NH_2CCl_3COOH.H_2O$.

100 gms. sat. solution of aniline tri chlor acetate in water contain 3.28 gms. $C_6H_5NH_2CCl_3COOH$ at 15° and 33.21 gms. at 55°. (Florence, 1927.)

**RICININE** $C_8H_8N_2O_2$.

### Solubility of Ricinine in Several Solvents.

(Winterstein, Koller and Weinhagen, 1917.)

| Solvent. | Gms. Ricinine dissolved per 100 cc. sat. sol.: cold. | hot. |
|---|---|---|
| Water | 0.345 | 10.35 |
| 95 % alcohol | 0.345 | 4.67 |
| Chloroform | 0.755 | — |
| Benzene | 0.030 | 0.16 |
| Pyridine | 2.050 (10 gms. at 24°) | 34.00 (at 115°-116°) |
| Methyl acetate | | 1.22 |

Solubility in Several Solvents of the Compound, $NH_2CO.C_6H_4.N = N.CO.NH_2$, Formed by the Action of Iodine upon Meta Benzamido-Semicarbazide (m. pt. 186°). (Doucet, 1923.)

| Solvent. | Gms. cmpd. per 100 gms. solvent at 15°. | Gms. cmpd. per 100 gms. solvent at b. pt. |
|---|---|---|
| Water | 0.07 | 3.25 |
| 95 % Ethyl alcohol | 0.70 | 2.20 |
| Acetone | 0.80 | - |

**VANILLIN** $C_6H_3.CHO.OCH_3.OH$, 1.3.4.

100 gms. $H_2O$ dissolve 1 gm. vanillin at 20–25°. (Dehn, 1917.)
100 gms. pyridine dissolve 316 gms. vanillin at 20–25°. "

Distribution of Vanillin between Water and Ether at 25°.
(Marden, 1914.)

| Gms. Vanillin per 100 cc. $H_2O$ Layer. | Gms. Vanillin per 100 cc. Ether Layer. | Dist. Coef. |
|---|---|---|
| 0.0164 | 0.1294 | 0.108 |
| 0.0242 | 0.1854 | 0.110 |
| 0.0403 | 0.3310 | 0.104 |

100 gms. sat. solution of Vanillin in 95.2% Ethyl Alcohol (d=0.8063) contain 48.42 gms. $CH_3O(OH)C_6H_3CHO$ at 25°. (Schnellbach and Rosin, 1931.)

Solubility of Vanillin in Aqueous Solutions of Ethyl Alcohol
(Mange and Ehler, 1924.)

The temperatures were determined at which weighed amounts of vanillin just dissolved in measured amounts of solvent. The results were plotted and the following table constructed from the diagram.

| Per cent $C_2H_5OH$ in solvent. | Gms. $C_6H_3CHO.OCH_3.OH$ per 100 cc. solvent. at 4°.4. | at 15°.6. | at 23°.9 |
|---|---|---|---|
| 0 (=$H_2O$ | 0.30 | 0.52 | 0.90 |
| 5 | 0.40 | 0.60 | 1.10 |
| 10 | 0.45 | 0.75 | 1.35 |
| 15 | 0.50 | 1.00 | 1.90 |
| 20 | 0.60 | 1.35 | 2.80 |
| 25 | 0.90 | 2.00 | 4.70 |
| 30 | 1.40 | 3.30 | |

100 gms. abs. alcohol dissolve 67.22 gms. vanillin at 20-25° (Pucher and Dehn, 1921.)
100 gms. quinoline » 5.51 » » » » » » » »
100 gms. equi. mol. mixture of alcohol and quinoline dissolve 64.30 gms. vanillin at 25°.

### Solubility of Vanillin in Aqueous Solutions of Glycerol.

(Mange and Ehler, 1924.)

The determinations could not be made at temperatures below 50° by the method used with alcohol solutions, due to the failure of vanillin to separate from the viscous glycerol mixtures, even on being supercooled by as much as 20°. An arbitrary method, which resembles the procedure used by flavor manufacturers in making vanillin solutions, was employed. This consisted in preparing, for each concentration of glycerol, a series of tubes in which different amounts of vanillin were dissolved by warming. These were kept at a nearly constant temperature (25° in one case and 13° in another) and shaken occasionally, during a period of one month. The mixtures which remained clear were seeded with a few crystals of vanillin in order to detect super saturation. Those which had been kept at 13° were nearly all supersaturated. The results were plotted and the following table was prepared. It shows the maximum amount of vanillin which will remain in solution under the usual conditions of preparing and storing commercial vanillin solutions.

| Per cent Glycerol in solvent. | Gms. $C_6H_3CHO.OCH_3.OH$ per 100 cc. solvent at | | |
|---|---|---|---|
| | 25°. | 13° (without seeding). | 13° (after seeding). |
| 0 (=$H_2O$... | 1.30 | 1.05 | 0.75 |
| 10..... | 1.50 | 1.30 | 0.82 |
| 20..... | 1.70 | 1.50 | 0.90 |
| 30..... | 2.00 | 1.90 | 1.00 |
| 40..... | 2.40 | 2.10 | 1.20 |
| 50..... | 2.80 | 2.50 | 1.35 |
| 60..... | 3.30 | 2.90 | 1.70 |
| 70..... | 4.00 | 3.40 | 2.25 |

100 cc. glycerol saturated by being agitated with excess of vanillin at 25°, and analyzed by extraction with ether, contained from 3.9 to 5.1 gms. $C_6H_3CHO.OCH_3.OH$. (Taylor and Bebie, 1924)

### Solubility of Vanillin in Aqueous Solutions of Glycerol at Temperatures Between 0°.2 and 60° (de Groote, 1920.)

The determinations were made by the method described under Coumarin on page 1190.

| Per cent 95 % Glycerol in solvent. | Gms. Vanillin dissolved per 100 cc. sat. solution at | | | | | |
|---|---|---|---|---|---|---|
| | 0°.2. | 20°. | 30°. | 40°. | 50°. | 60°. |
| 0.0 (= $H_2O$)..... | 0.68 | 1.25 | 1.50 | 2.65 | 4.80 | 5.05 |
| 5.0..... | 0.70 | 1.50 | 1.60 | 3.00 | 4.90 | 5.20 |
| 10.0..... | 0.75 | 1.75 | 1.80 | 3.40 | 5.50 | 6.50 |
| 15.0..... | 0.85 | 1.95 | 2.35 | 4.00 | 6.25 | 7.20 |
| 20.0..... | 0.95 | 2.30 | 2.50 | 4.20 | 7.50 | 8.25 |
| 25.0..... | 1.10 | 2.50 | 2.70 | – | 8.75 | 11.20 |
| 30.0..... | 1.25 | 2.95 | 3.00 | 5.3 | 10.0 | 12.8 |
| 40.0..... | 1.50 | 3.50 | 3.80 | 6.0 | 12.0 | 15.0 |
| 50.0..... | 2.06 | 4.50 | 5.00 | 7.4 | 14.8 | 20.0 |

Fusion-point data for mixtures of vanillin and orthovanillin are given by Noelting (1910). Qualitative solubilities of orthovanillin in a number of solvents are also reported. Data for the sintering, melting and clear liquid points for mixtures of vanillin and an extensive series of compounds are given by Lehmann (1914).

Freezing-point data for mixtures of vanillin and acenaphthene are given by Fazi, 1916, and for mixtures of vanillin with chlor acetic acid and with tri chlor acetic acid by Kendall and Gibbons, 1915.

## METHOXY BENZOIC ACID o $CH_3O.C_6H_4COOH$.

### Distribution of Ortho Methoxy Benzoic Acid at 25° Between:
(Smith and White, 1929.)

| Water and Chloroform | | Water and Toluene | |
|---|---|---|---|
| Gm. Mol. o $C_8H_8O_3$ per liter | | Gm. Mol. o $C_8H_8O_3$ per liter | |
| $H_2O$ layer | $CHCl_3$ layer | $H_2O$ layer | $C_6H_5CH_3$ layer |
| 0.00244 | 0.0886 | 0.0077 | 0.0222 |
| 0.00330 | 0.1150 | 0.0097 | 0.0297 |
| 0.00370 | 0.1325 | 0.0110 | 0.0345 |
| 0.00416 | 0.1520 | 0.0125 | 0.0398 |
| 0.00475 | 0.1690 | 0.0141 | 0.0460 |
| 0.00548 | 0.1870 | 0.0156 | 0.0537 |
| | | 0.178 | 0.0620 |

Freezing-point data for mixtures of o methoxy benzoic acid and sarcosine anhydride are given by Pfeiffer, Angern, Wang, Seydel and Quehl, 1930.

## ANISIC ACID (*p*-Methoxybenzoic Acid) $CH_3O.C_6H_4COOH$.

1000 cc. sat. aqueous solution contain 0.2263 gm. acid at 25°. (Paul, 1894.)

### Mutual Solubility of Anisic (p Methoxy Benzoic) Acid and Water, Determined by the Synthetic Method.
(Flaschner and Rankin, 1910.)

| t° | Gms. $C_8H_8O_3$ per 100 gms. mixture | t° | Gms. $C_8H_8O_3$ per 100 gms. mixture |
|---|---|---|---|
| 138.2 | (Crit. temp.) | 146 | 59.4 |
| 140 | 9.0 | 150 | 73.3 |
| 142 | 12.0 | 160 | 89.8 |
| 144 | 18.0 | 170 | 95.6 |
| 145 | 30.0 | 184 | 100.0 |

### Solubility of Anisic Acid in Several Alcohols.
(Timofeiew, 1894.)

| t°. | In Methyl Alcohol. Gms. per 100 Gms. | | In Ethyl Alcohol. Gms. per 100 Gms. | | In Propyl Alcohol. Gms. per 100 Gms. | |
|---|---|---|---|---|---|---|
| | Sat. Sol. | Solvent. | Sat. Sol. | Solvent. | Sat. Sol. | Solvent |
| 0 | 51.1 | 104.5 | 46.7 | 87.6 | 35 | 53.8 |
| 16.5 | 64.9 | 183.5 | 53.6 | 115.5 | 43 | 75.5 |

Data for the distribution of anisic acid between water and olive oil at 25° are given by Boëseken and Waterman (1911, 1912).

## ANISIC ACID (*p* Methoxy Benzoic Acid) $CH_3O.C_6H_4.COOH$.

DISTRIBUTION OF ANISIC ACID BETWEEN : (Smith, 1921-1922.)

Water and Xylene at 25°.

| Millimols Anisic Acid per liter of $H_2O$ layer ($C_1$). | Millimols Anisic Acid per liter of Xylene layer ($C_2$). | $\frac{C_2}{C_1}$. |
|---|---|---|
| 0.243 | 0.195 | 0.802 |
| 0.381 | 0.494 | 1.30 |
| 0.467 | 0.700 | 1.50 |
| 0.682 | 1.50 | 2.20 |

Water and Chloroform at 25°.

| Millimols Anisic Acid per liter of $H_2O$ layer ($C_1$). | Millimols Anisic Acid per liter of $CHCl_3$ layer ($C_2$). | $\frac{C_2}{C_1}$. |
|---|---|---|
| 0.125 | 0.625 | 5.00 |
| 0.162 | 0.875 | 5.38 |
| 0.206 | 1.206 | 5.85 |
| 0.225 | 1.75 | 6.36 |

DISTRIBUTION OF ANISIC ACID AT 25° BETWEEN:
(Smith and White, 1929.)

Water and Chloroform

| Gm. Mols. $C_8H_8O_3$ per liter $H_2O$ layer | Gm. Mols. $C_8H_8O_3$ per liter $CHCl_3$ layer |
|---|---|
| 0.000924 | 0.0233 |
| 0.00106 | 0.0268 |
| 0.00119 | 0.0306 |
| 0.00139 | 0.0361 |
| 0.00158 | 0.0418 |
| 0.00178 | 0.0478 |

Water and Toluene

| Gm. Mols. $C_8H_8O_3$ per liter $H_2O$ layer | Gm. Mols. $C_8H_8O_3$ per liter $C_6H_5CH_3$ layer |
|---|---|
| 0.000924 | 0.00370 |
| 0.001056 | 0.00449 |
| 0.00119 | 0.00528 |
| 0.00132 | 0.00607 |
| 0.00158 | 0.00818 |
| 0.00172 | 0.00950 |

Freezing-point data for mixtures of anisic acid and sarcosine anhydride are given by Pfeiffer, Angern, Wang, Seydel and Quehl, 1930.

## METHYL p OXY BENZOATE $OHC_6H_4COOCH_3$.

Freezing-point data for mixtures of p oxy benzoic methyl ester with antipyrinė, with pyramidon and with sarcosine anhydrid are given by Pfeiffer and Seydel, 1928b.

## METHYL SALICYLATE $C_6H_4OH.COOCH_3$.

100 cc. $H_2O$ dissolve 0.074 gm. $C_6H_4OH.COOCH_3$ at 30°. (Gibbs, 1908.)
100 cc. 0.1 *n* $H_2SO_4$ dissolve 0.077 gm. $C_6H_4OH.COOCH_3$ at 30°. "

SOLUBILITY OF METHYL SALICYLATE IN AQUEOUS ALCOHOL AT 25°. (Seidell, 1910.)

| Wt. % $C_2H_5OH$ in Solvent. | $d_{25}$ of Sat. Sol. | Gms. $C_6H_4OH.COOCH_3$ per 100 Gms. Sat. Sol. | Wt. % $C_2H_5OH$ in Solvent. | $d_{25}$ of Sat. Sol. | Gms. $C_6H_4OH.COOCH_3$ per 100 Gms. Sat. Sol. |
|---|---|---|---|---|---|
| 0 | 1 | 0.12 | 60 | 0.923 | 18.60 |
| 30 | 0.958 | 0.60 | 65 | 0.929 | 30.50 |
| 40 | 0.940 | 2.30 | 70 | 0.943 | 39.40 |
| 50 | 0.925 | 6.20 | 75 | 0.974 | 58.50 |
| 55 | 0.922 | 10 | 80 | 1.050 | 72 |

SOLUBILITY OF METHYL SALICYLATE IN AQUEOUS ALCOHOL AT DIFFERENT TEMPERATURES. (Seidell, 1910.)

| Wt. % $C_2H_5OH$ in Solvent. | Gms. $C_6H_4OH.COOCH_3$ per 100 cc. Solvent at: | | | |
|---|---|---|---|---|
| | 15°. | 20°. | 25°. | 30°. |
| 0 | (about) 0.1 | 0.1 | 0.1 | 0.1 |
| 30 | 0.3 | 0.4 | 0.5 | 0.6 |
| 40 | 0.8 | 1.1 | 1.4 | 1.8 |
| 50 | 2.4 | 3.5 | 5 | 6 |
| 55 | 4.2 | 6 | 7.8 | 9.5 |
| 60 | 7.7 | 10 | 12.5 | 15.5 |
| 65 | 13 | 16.5 | 20.2 | 24.5 |
| 70 | 22 | 28 | 33 | 40 |
| 75 | 43 | 52 | 62 | 72 |
| 80 | 92 | 135 | 180 | 230 |

SOLUBILITY OF METHYL SALICYLATE AT 20° IN AQUEOUS 50 WT. PER CENT ETHYL ALCOHOL SATURATED WITH VARIOUS SALTS. (Wright, 1926.)

| Solvent. | Gms. $C_6H_4OH.COOCH_3$(o). per 100 gms. sat. sol. | Gms. Salt. per 100 gms. sat. sol. |
|---|---|---|
| Aq. 50 Wt. % $C_2H_5OH$ | .... 6.2 | 0.0 |
| " + excess NaCl | .... 8.2 | 10.2 (NaCl) |
| " + " $NaNO_3$ | .... 8.1 | 20.4 ($NaNO_3$) |
| " + " KCl | .... 7.2 | 6.2 (KCl) |
| " + " $KNO_3$ | .... 6.9 | 3.8 ($KNO_3$) |
| " + " KBr | .... 7.9 | 17.3 (KBr) |

Freezing-point data for mixtures of methyl salicylate and cineole are given by Bellucci and Grassi, 1913.)

**MANDELIC ACID** (Phenyl Glycolic Acid) $C_6H_5.CHOH.COOH$.

100 cc sat. sol. of Mandelic acid in $H_2O$ contain 12.65 gms. $C_6H_5CHOH.COOH$ at 19°.

100 cc sat. sol. of Mandelic acid in $C_6H_6$ contain 0.0746 gms. $C_6H_5CHOH.COOH$ at 19°.

SOLUBILITY OF DEXTRO AND OF LAEVO MANDELIC ACIDS IN WATER.

| Acid | t° | Gms. $C_8H_8O_3$ per 100 gms. $H_2O$ | Authority |
|---|---|---|---|
| Dextro Mandelic Acid | 15 | 7.26 | Kortium, 1931. |
| Laevo " " | 15 | 7.24 | " " |
| Dextro " " | 25 | 11.36 | Campbell and Garrow, 1930 |
| Laevo " " | 25 | 10.98 | " " " |

FREEZING-POINTS OF MIXTURES OF ACTIVE MANDELIC (PHENYL GLYCOLIC) ACID AND WATER.
(Timmermans and Motiuk, 1932.)

| t° | Gms. $C_8H_8O_3$ per 100 gms. $H_2O$ | t° | Gms. $C_8H_8O_3$ per 100 gms. $H_2O$ |
|---|---|---|---|
| -0.24 | 1.84 | -0.70 | 5.75 |
| -0.46 | 3.69 | -0.84 | 7.14 |
| -0.60 | 4.85 | -0.93 | 7.99 |
| -0.67(Eutec.) | 5.57 | | |

## Solubility of Mandelic Acid at 25° in Aqueous Solutions of :

(Knox and Richards, 1919.)

### Acetic Acid.

| Equiv. Normality of $CH_3COOH$. | $C_8H_8O_3$. |
|---|---|
| 0.870 | 1.808 |
| 1.338 | 2.312 |
| 1.860 | 2.664 |
| 2.618 | 3.186 |
| 3.644 | 3.441 |
| 4.249 | 3.479 |
| 4.738 | 3.487 |
| 6.485 | 3.509 |
| 8.60 | 3.234 |
| 9.85 | 2.996 |
| 12.30 | 2.178 |

### Formic Acid.

| Equiv. Normality of HCOOH. | $C_8H_8O_3$. |
|---|---|
| 0.0 | 1.191 |
| 2.268 | 1.768 |
| 4.340 | 2.180 |
| 6.320 | 2.380 |
| 8.09 | 2.430 |
| 10.38 | 2.434 |
| 12.20 | 2.525 |
| 13.41 | 2.750 |
| 13.78 | 3.327 |

### Hydrochloric Acid.

| Equiv. Normality of HCl. | $C_8H_8O_3$. |
|---|---|
| 0.0 | 1.191 |
| 1.202 | 0.691 |
| 2.481 | 0.488 |
| 3.753 | 0.387 |
| 5.017 | 0.332 |
| 6.271 | 0.307 |
| 7.523 | 0.302 |
| 8.748 | 0.316 |
| 9.937 | 0.353 |
| 10.35 | 0.375 |

### Sulfuric Acid.

| Equiv. Normality of $H_2SO_4$. | $C_8H_8O_3$. |
|---|---|
| 0.00 | 1.191 |
| 2.695 | 0.484 |
| 5.390 | 0.278 |
| 8.294 | 0.186 |
| 11.05 | 0.180 |
| 13.62 | 0.180 |
| 16.5 | 0.16 |
| 18.89 | 0.23 |
| 21.17 | 0.27 |

## Solubility of Racemic (r) Mandelic Acid in Aqueous Solutions of Metal Mandelates at 25°.

(Ross and Morrison, 1936; Ross, Morrison and Johnstone, 1938.)

| Gm. Equiv. per 1000 gms. $H_2O$ | | |
|---|---|---|
| (r) Mandelate | | (r) Mandelic Acid |
| 0.0 | (= $H_2O$ | 1.34 |
| 0.02 | $C_8H_7O_3Cs$ | 1.138 |
| 0.06 | " | 1.51 |
| 0.13 | " | 1.72 |
| 0.22 | " | 2.04 |
| 0.05 | $C_8H_7O_3K$ | 1.44 |
| 0.16 | " | 1.65 |
| 0.22 | " | 1.91 |
| 0.415 | " | 2.36 |
| 0.10 | $C_8H_7O_3Li$ | 1.413 |
| 0.20 | " | 1.491 |
| 0.25 | " | 1.555 |
| 0.014 | $C_8H_7O_3Tl$ | 1.35 |
| 0.06 | " | 1.44 |
| 0.112 | " | 1.583 |
| 0.177 | " | 1.79 |
| 0.209 | " | 2.09 |

| Gm. Equiv. per 1000 gms. $H_2O$ | | |
|---|---|---|
| (r) Mandelate | | (r) Mandelic Acid |
| 0.171 | $C_8H_7O_3NH_4$ | 1.598 |
| 0.366 | " | 2.05 |
| 0.476 | " | 2.33 |
| 0.062 | $(C_8H_7O_3)_2Ba$ | 1.45 |
| 0.03 | $(C_8H_7O_3)_2Mg$ | 1.34 |
| 0.130 | " | 1.407 |
| 0.05 | $C_8H_7O_3Rb$ | 1.44 |
| 0.143 | " | 1.652 |
| 0.210 | " | 1 851 |
| 0.113 | $C_8H_7O_3Na$ | 1.442 |
| 0.213 | " | 1.584 |
| 0.277 | " | 1.690 |
| 0.031 | $(C_8H_7O_3)_2Sr$ | 1.38 |

## Distribution of Mandelic Acid at 25° Between :

(Smith, 1921, 1922.)

### Water and Ethyl Ether.

| Millimols. $C_6H_5CHOH.COOH$ per liter of | | $\frac{C_2}{C_1}$. |
|---|---|---|
| $H_2O$ layer ($C_1$). | $(C_2H_5)_2O$ layer ($C_2$). | |
| 0.885 | 1.175 | 1.330 |
| 1.070 | 1.475 | 1.380 |
| 2.100 | 2.95 | 1.405 |
| 3.225 | 4.825 | 1.495 |
| 5.225 | 8.525 | 1.63 |

### Acetone and Glycerol.

| Millimols. $C_6H_5CHOH.COOH$ per liter of | | $\frac{A}{G}$. |
|---|---|---|
| Acetone layer (A). | Glycerol layer (G). | |
| 4.225 | 2.075 | 2.04 |
| 8.65 | 4.25 | 2.04 |
| 16.45 | 8.25 | 1.99 |
| 23.0 | 11.6 | 1.98 |

## Solubility of Laevo (-) Mandelic Acid in Aqueous Solutions of Metal Mandelates at 25°.

(Ross, Morrison and Johnstone, 1938.)

| Gm. Equiv. per 1000 gms. $H_2O$ | | | Gm. Equiv. per 1000 gms. $H_2O$ | | |
|---|---|---|---|---|---|
| (-) Metal Mandelate | | (-) Mandelic Acid | (-) Metal Mandelate | | (-) Mandelic Acid |
| 0.0 | (= $H_2O$) | 0.738 | 0.120 | $(C_8H_7O_3)_2Ba$ | 0.763 |
| 0.112 | $C_8H_7O_3Cs$ | 0.777 | 0.166 | " | 0.815 |
| 0.210 | " | 0.857 | 0.198 | " | 0.840 |
| 0.310 | " | 0.971 | 0.186 | $(C_8H_7O_3)_2Mg$ | 0.758 |
| 0.193 | $C_8H_7O_3K$ | 0.803 | 0.294 | " | 0.792 |
| 0.384 | " | 0.970 | 0.100 | $C_8H_7O_3Rb$ | 0.766 |
| 0.146 | $C_8H_7O_3Li$ | 0.756 | 0.200 | " | 0.837 |
| 0.186 | " | 0.766 | 0.300 | " | 0.922 |
| 0.246 | " | 0.788 | 0.400 | " | 1.035 |
| 0.030 | $(C_8H_7O_3)_2Ca$ | 0.747 | 0.059 | $C_8H_7O_3Na$ | 0.737 |
| 0.063 | " | 0.755 | 0.112 | " | 0.755 |
| 0.075 | " | 0.776 | 0.292 | " | 0.853 |
| 0.153 | $C_8H_7O_3Tl$ | 0.874 | 0.341 | " | 0.877 |
| 0.222 | " | 0.915 | 0.616 | " | 1.008 |
| 0.325 | " | 1.084 | 0.157 | $C_8H_7O_3NH_4$ | 0.757 |
| 0.104 | $(C_8H_7O_3)_2Sr$ | 0.776 | 0.358 | " | 0.884 |
| 0.140 | " | 0.812 | 0.581 | " | 1.068 |

The authors also give results at 25° for the solubility of racemic and of dextro Mandelic Acids in aqueous 0.05 molecular solutions of the respective metal mandalates to which increasing amounts of various metal chlorides and nitrates were added. Their results for equilibrium in systems composed of metal mandelates, mandelic acid and water will be found in Vol. I under the respective metals as follows: Ba mandelate p. 145, Ca mandelate p, 258, Cs mandelate p, 453, K mandelate p. 712, Li mandelate p. 906, $NH_4$ mandelate p. 1061, Na mandelate p. 1178, Rb mandelate p. 1431 and Tl mandelate, p. 1540.

## Distribution of Mandelic Acid at 19° Between :

(Schilow and Lepin, 1922.)

### Water and Benzene.

| Gms. $C_6H_5CHOH.COOH$ per 100 cc. | | |
|---|---|---|
| $H_2O$ layer ($C_1$). | $C_6H_6$ layer ($C_2$). | $\frac{C_1}{C_2}$. |
| 1.46 | 0.0165 | 89 |
| 2.99 | 0.0336 | 89 |
| 4.22 | 0.0468 | 90 |
| 6.74* | 0.0746* | 90 |

*Excess mandelic acid present.

### Water and Anisole.

| Gms. $C_6H_5CHOH.COOH$ per 100 cc. | | |
|---|---|---|
| $H_2O$ layer ($C_1$). | Anisole layer ($C_2$). | $\frac{C_1}{C_2}$. |
| 1.05 | 0.189 | 5.6 |
| 1.383 | 0.258 | 5.4 |
| 4.00 | 0.752 | 5.3 |
| 4.56 | 0.852 | 5.4 |
| 6.325 | 1.178 | 5.4 |
| 7.16* | 1.325* | 5.4 |

### Distribution of Mandelic Acid at 25° Between Water and Chloroform.
(Smith and White, 1929.)

| Gm. Mols. $C_8H_8O_3$ per liter | |
|---|---|
| $H_2O$ layer | $CHCl_3$ layer |
| 0.0218 | 0.00106 |
| 0.0348 | 0.00165 |
| 0.0396 | 0.00185 |
| 0.0458 | 0.00211 |
| 0.0522 | 0.00244 |
| 0.0605 | 0.00290 |
| 0.0695 | 0.00317 |

Experiments on the distribution of r Mandelic acid between water and d Carvon are given by Schroer, 1932.

### Solubility of Mandelic Acid in Several Solvents.

| Solvent. | t°. | Gms. $C_6H_5CHOHCOOH$ per 100 Gms. Sat. Sol. | | Authority. |
|---|---|---|---|---|
| Water | 20 | 15.95 | (inactive acid) | (Schlossberg, 1900.) |
| " | 20 | 19.17 | (dextro acid) | " |
| Methyl Alcohol | 0 | 51.1 | (inactive acid) | (Timofeiew, 1894.) |
| " " | 16.5 | 64.9 | " | " |
| Ethyl Alcohol | 0 | 46.7 | " | " |
| " " | 16.5 | 53.6 | " | " |
| Propyl Alcohol | 0 | 35 | " | " |
| " " | 16.5 | 43 | " | " |
| 95% Formic Acid | 19 | 40 | " | (Aschan, 1913.) |

### Solubility of Dextro and of Racemic Phenyl Glycolic Acid in Chloroform.
(Holleman, 1898.)

| t°. | Gms. Detro Acid per 100 Gms. $CHCl_3$. | t°. | Gms. Racemic Acid per 100 Gms. $CHCl_3$. |
|---|---|---|---|
| 15 | 0.952 | 15 | 0.877 |
| 25 | 1.328 | 25 | 1.07 |
| 35 | 1.950 | 35 | 1.60 |

Freezing-point data are given for mixtures of:

d + l Mandelic acid (Adriani, 1900.)
r + l " " " "
r + l Mandelic acid methyl esters (Centnerszwer, 1899.)
r + l " " iso butyl esters " "
l + d " " menthyl esters (Findlay and Hickmans, 1907.)
r Mandelic acid + dimethyl pyrone (Kendall, 1914.)
Mandelic acids + Aspariginic acid + $H_2O$ (Timmermans and Motiuk, 1932.)
" " + Chloro succinic acid + $H_2O$ " " "
" " + Malic acid + $H_2O$ " " "
" " + Phenyl amino acetic acid + $H_2O$ " " "
" " + Tartaric acid + $H_2O$ " " "
" " + Lactamide (Timmermans, van Lancker and Jaffe, 1939.)

## Nitro**ACETANILIDES** $NO_2C_6H_4NHCOCH_3$, *o*, *m* and *p*.

### Solubility of Each in Water. (Sidgwick and Rubie, 1921.)

The synthetic method was used. Both the triple points and the critical solution temperatures, for the two liquid layerers which separate, were determined. Asterisks indicate that a solid phase is present.

Ortho Nitroacetanilide.

| t°. | Gms. $NO_2C_6H_4NHCOCH_3$ per 100 gms. sat. sol. |
|---|---|
| 93.4.... | 100.0* |
| 92.4.... | 99.38* |
| 83 2.... | 97.11* |
| 81.0.... | 96.0* tr. pt. |
| 99.0.... | 94.54 |
| 110.2.... | 93.65 |
| 173.1.... | 83.47 |
| 188.0.... | 76.28 |
| 195.0.... | 65.04 |
| 198.0.... | 50 crit. temp. |
| 197.0.... | 41 16 |
| 191 2.... | 24.06 |
| 179.2.... | 11 97 |
| 157.6.... | 8.04 |
| 120.0.... | 3.97 |

Meta Nitroacetanilide.

| t°. | Gms. $NH_2C_6H_4NHCOCH_3$ per 100 gms. sat. sol. |
|---|---|
| 154.5.... | 100.0* |
| 129.2.... | 93.57* |
| 124.2.... | 91.72 |
| 118.5.... | 90.0* tr. pt. |
| 149.2.... | 81.18 |
| 166.4.... | 73.74 |
| 175.7.... | 66.08 |
| 180.0.... | 50 crit. temp. |
| 176.9.... | 31.13 |
| 163.5.... | 14.52 |
| 130.0.... | 5.21 |

Para Nitroacetanilide.

| t°. | Gms. $NO_2C_6H_4NHCOCH_3$ per 100 gms. sat. sol. |
|---|---|
| 215.9... | 100.0* |
| 192.2... | 95.2* |
| 163.6... | 81.84* |
| 161.5... | 80.0* tr. pt. |
| 171.7... | 65.84 |
| 176.6... | 54.93 |
| 178.0... | 50 crit. temp. |
| 177.4... | 42.65 |
| 172.8... | 25.62 |
| 164.2... | 14.36 |
| 156.5... | 7.08* |
| 145.1... | 2.94 |

### Solubility of Ortho, Meta and Para Nitroacetanilides in Benzene. (Sidgwick and Rubie, 1921.)

Ortho Nitroacetanilide.

| t°. | Gms. $NO_2C_6H_4NHCOCH_3$ per 100 gms. sat. sol. |
|---|---|
| 81.2..... | 87.58 |
| 76.4..... | 79.08 |
| 71.5..... | 67.97 |
| 68.0..... | 54.97 |
| 58.5..... | 31.49 |
| 46.8..... | 16.44 |
| 39.0..... | 10.26 |

Meta Nitroacetanilide.

| t°. | Gms. $NO_2C_6H_4NHCOCH_3$ per 100 gms. sat. sol. |
|---|---|
| 154.5..... | 100.0 |
| 135.3... | 83.07 |
| 126.8..... | 65.27 |
| 121.2..... | 35.13 |
| 115.0..... | 13.47 |
| 102.0..... | 5.04 |

Para Nitroacetnailide.

| t°. | Gms. $NO_2C_6H_4NHCOCH_3$ per 100 gms. sat. sol. |
|---|---|
| 197.4..... | 87.48 |
| 186.5..... | 72.62 |
| 180.3..... | 54.78 |
| 179.4..... | 49.93 |
| 177.5..... | 37.75 |
| 172.6..... | 17.47 |
| 150.6..... | 5.23 |

### Solubility of Ortho and of Para Nitroacetanilide in Water and in Aqueous Solutions of Acetic and Nitric acids at Ordinary Temperature. (Franzel and Engel, 1921.)

| | Acetanilide. | Solvent. | Gms. Acetanilide per 100 cc. solvent. |
|---|---|---|---|
| o | Nitroacetanilide | Water | 0,22 |
| o | » | Water containing 9.1 cc. $CH_3COOH$ per 100 cc | 1.04 |
| o | » | » 15.9 cc. $HNO_3$ per 100 cc | 0.96 |
| o | » | » 7.7 cc. acetic + 14.4 cc. $HNO_3$ per 100 cc. | 0.89 |
| p | » | Water | 0.22 |
| p | » | Water containing 7.7 cc. acetic + 14.4 cc. $HNO_3$ per 100 cc. | 0.89 |

### Solubility of Para Nitro Acetamide in Aqueous and in Glacial Acetic Acid.

(Orton and King, 1911.)

| Solvent | t° | Gms. p $NO_2C_6H_4NHCOCH_3$ per 100 gms. sat. sol. |
|---|---|---|
| Aq. 50% Acetic Acid | 16 | 0.38 |
| Glacial Acetic Acid | 16 | 0.83 |

Freezing-point data are given for mixtures of:

o Nitracetanilide + o nitraniline (Jaeger, 1906.)
p " + acetanilide (Küster, 1891.)
p " + di nitro acetanilide (Holleman and Sluiter, 1906.)

## Hydroxy TOLUIC ACIDS

$C_6H_3COOH.OH.CH_3$. 1,2,3; 1,2,4; 1,2,5; 1,3,4 and 1,4,3.

Solubility of Each Separately in Water. (Sidgwick and Ewbank, 1921 *a*.)

The determinations were made by the synthetic method and all details for accurate work were carefully observed. The results are expressed in wt. % that is, in grams of acid per 100 grams of saturated solution. L indicates that a second liquid layer separated. The position of the substituent groups in the several acids are numbered in the order, CO OH, OH and $CH_3$. Thus the 1, 2, 3 acid is $C_6H_3$.(1) CO OH.(2) OH.(3) $CH_3$, the 1.2.4 acid is $C_6H_3$.(1) CO OH.(2).OH (4) $CH_3$, the 1, 2, 5 acid is $C_6H_3$.(1) CO OH.(2) OH.(5) $CH_3$, the 1, 3, 4 acid is $C_6H_3$.(1) CO OH .(3) OH.(4) $CH_3$ and the 1, 4, 3 acid is $C_6H_3$.(1) CO OH.(4) OH.(3) $CH_3$.

Results for the 1, 2, 3 Acid.

| t°. | Wt. %. |
|---|---|
| 167.0... | 100.00 |
| 147.5... | 90.07 |
| 134.5... | 80.50 |
| 134.1... | 79.68 |
| 129.8... | 69.52 |
| 120.3... | – L |
| 148.0... | 59.73 L |
| 151.3... | 50.51 L |
| 153.5 cr | – L |
| 153.3... | 29.81 L |
| 149.3... | 10.18 L |
| 131.8... | 5.07 I |
| 129.2 tr. | – |
| 119.1... | 2.20 |
| 80.7... | 0.364 |

Results for the 1, 2, 4 Acid.

| t°. | Wt. %. |
|---|---|
| 177.8... | 100.00 |
| 147.8... | 89.68 |
| 138.3... | 79.68 |
| 132.6... | 67.68 |
| 139.4... | 54.40 L |
| 144.6... | 41.46 L |
| 145.2Cr. | – L |
| 144.6... | 19.89 L |
| 138.4... | 9.75 I |
| 131.0 tr. | – |
| 129.4... | 5.53 |
| 125.3... | – L |
| 80.7... | 0.412 |

Results for the 1, 2, 5 Acid.

| t°. | Wt. %. |
|---|---|
| 152.5... | 100.00 |
| 126.4... | 89.71 |
| 112.0... | 79.66 |
| 109.5... | 77.05 |
| 117.7... | 69.29 L |
| 120.2... | 67.91 L |
| 131.5... | 59.85 L |
| 135.6... | 55.16 L |
| 142.0.. | 38.85 L |
| 142.8Cr. | – L |
| 142.5... | 24.55 L |
| 138.5... | 10.21 L |
| 117.5... | 4.53 L |
| 107.8 tr. | – |
| 85.0... | 0.92 |
| 80.7... | 0.73 |

Results for the 1, 3, 4 Acid.

| t°. | Wt. %. |
|---|---|
| 208.5... | 100.00 |
| 154.6... | 76.98 |
| 143.0... | 66.07 |
| 131.4... | 48.67 |
| 124.2... | 30.23 |
| 113.1... | 10.33 |
| 98.8... | 4.03 |

Results for the 1, 4, 3 Acid.

| t°. | Wt. %. |
|---|---|
| 172.4... | 100.00 |
| 146.8... | 84.12 |
| 132.4... | 65.59 |
| 124.1... | 47.57 |
| 118.8... | 30.87 |
| 109.0... | 9.61 |
| 105.8... | 6.52 |
| 103.4... | 5.77 |
| 99.5t.h. | 5.01 |
| 96.6... | 3.70 |
| 92.6... | 2.77 |
| 84.4... | 1.83 |

Cr. = Critical Solution Temp.
tr. = Triple point.
t. h. = Transition point of hydrate.

SOLUBILITY OF HYDROXY TOLUIC ACIDS IN BENZENE. (Sidgwick and Ewbank, 1921 *a*.

| 1, 2, 3 Acid. | | 1, 2, 4 Acid. | | 1, 2, 5 Acid. | | 1, 3, 4 Acid. | | 1, 4, 3 Acid. | |
|---|---|---|---|---|---|---|---|---|---|
| t°. | Wt. %. | t°. | Wt. %. | t°. | Wt. %. | t°. | Wt. %. | t°. | Wt. %. |
| 155.4... | 90.33 | 167.6... | 91.6 | 142.0... | 91.10 | 202.5... | 91.7 | 166.0... | 90.7 |
| 138.3... | 69.92 | 150.3... | 71.7 | 124.7... | 70.36 | 192.0... | 72.7 | 152.8... | 71.7 |
| 123.0... | 49.18 | 135.1. . | 50.7 | 110.6... | 52.05 | 183.7... | 50.0 | 145.0... | 52.6 |
| 107.2... | 29.96 | 117.6... | 29.33 | 93.3... | 29.98 | 176.5... | 29.8 | 139.5... | 29.8 |
| 79..... | 9.67 | 90.2... | 9.74 | 68.0... | 10.53 | 160.5... | 9.8 | 126.2... | 10.11 |
| 62.4... | 5.23 | 71.7... | 4.96 | 48.8... | 4.73 | 147.4... | 4.87 | 116.7... | 4.78 |
| 45.2... | 2.01 | 48.8... | 2.02 | 30.0... | 1.76 | 131.6... | 2.18 | 109.5... | 2.78 |

SOLUBILITY OF HYDROXY TOLUIC ACIDS IN *n* HEPTANE. (Sidgwick and Ewbank, 1921 *a*.)

| 1, 2, 3 Acid. | | 1, 2, 4 Acid. | | 1, 2, 5 Acid. | | 1, 3, 4 Acid. | | 1, 4, 3 Acid. | |
|---|---|---|---|---|---|---|---|---|---|
| t°. | Wt. %. | t°. | Wt. %. | t°. | Wt. %. | t°. | Wt. %. | t°. | Wt. %. |
| 154.3... | 88.95 | 166.7... | 79.29 | 145.9... | 189.9 | 180.0... | 0.94 | 163.8... | 1.40 |
| 146.6... | 70.04 | 162.2... | 61.03 | 138.7... | 69.9 | | | 156.0... | 1.40L |
| 141.9... | 52.03 | 156.6... | 36.28 | 135.5.. | 50.0 | | | 157.3... | 1.02 |
| 140.9... | 47.63 | 147.1... | 20.15 | 131.1.. | 30.38 | | | 135.0... | 1.02L |
| 132.9... | 24.77 | 135.6... | 10.00 | 116.2... | 10.42 | 202.0 tr. | | 168.0 tr. | |
| 119.0... | 9.95 | 116.7... | 4.51 | 97.1.. | 4.59 | | | | |
| 101.0... | 4.86 | 100.6... | 2.22 | 79.0 .. | 1.84 | | | | |
| 81.0... | 1.89 | | | | | | | | |

## DI NITRO p XYLENES $(NO_2)_2C_6H_2(CH_3)_2$.

Freezing-point data for mixtures of 2.3 and 2.6 di nitro p xylenes are given by Blanksma, 1913.

Results for mixtures of 2.6 di nitro xylene and acenaphthene are given by Hertel and Kleu, 1930.

## TRI NITRO ETHYL ANILINE 2,4,6- $(NO_2)_3C_6H_2NH.C_2H_5$.

100 gms. $H_2O$ dissolve 0.010 gm. $C_8H_8O_6N_4$ at 19°, 0.031 gm. at 50° and 0.140 gm. at 100°. (Desvergnes, 1926.)

## NITROSO META XYLENE (4) $NOC_6H_3(CH_3)_2$.

Freezing-point data for mixtures of Nitroso meta xylene with o nitroso toluene and with nitroso mesitylene are given by Hammick, Edwards, Illingworth and Snell, 1933.

## ACETANILIDE $C_6H_5NH.COCH_3$.

### Solubility of Acetanilide in Water. (Schoorl and de Weerd, 1922.)

| t°. | Gms. $C_6H_5NH.COCH_3$ per 100 gms. sat. sol. | Solid Phase. |
|---|---|---|
| —0.03 (Eutec.) | 0.5 | Ice + $C_6H_5NH.COCH_3$ |
| 15..... | 0.5 (0.4)* | $C_6H_5NH.COCH_3$ |
| 20..... | 0.52 (0.45) | » |
| 30..... | 0.63 (0.51) | » |
| 40..... | 0.86 (0.65) | » |
| 50..... | 1.25 (0.81) | » |
| 60..... | 2.0 | » |
| 70..... | 3.0 | » |
| 80..... | 4.5 | » |
| 83.2..... | 5.2 Quad. pt. | » + liquid layers |
| 83.2..... | 87.0 | » » |
| 85..... | 91.0 | $C_6H_5NH.COCH_3$ |
| 90..... | 94.5 | » |
| 95.0..... | 96.5 | » |
| 100.0..... | 98.0 | » |
| 114.0..... | 100.0 m. pt. | » |

The liquid layers which separate above 83°.2 have the following composition.

| t°. | Gms. $C_6H_5NHCOCH_3$ per 100 gms. $H_2O$ rich layer. | Gms. $C_6H_5NHCOCH_3$ per 100 gms. $C_6H_5NH.COCH_3$ rich layer. |
|---|---|---|
| 83.2.... | 5.2 | 87.0 |
| 90.0.... | 5.8 | 82.5 |
| 100.0.... | 6.5 | 80.5 |
| 120.0.... | 13.0 | 79.0 |
| 130.0.... | 18.0 | 73.0 |
| 135.0.... | 22.0 | 69.0 |
| 140.0.... | 28.0 | 63.0 |
| 142.0.... | 30.0 | 60.0 |
| 144.0 (crit. t.) | 45.0 | |

* These results, which are probably low, are given by Oliveri-Mandala and Forni, 1925.

### Solubility of Acetanilide in Water and Ethyl Alcohol. (Wright, 1927.)

| Solvent | Gms. $C_6H_5NH.COCH_3$ per 100 gms. solvent at: 20° | 30° |
|---|---|---|
| Water | 0.525 | 0.71 |
| Aq. 50 Wt. % $C_2H_5OH$ | 11.9 | 18.8 |
| Pure $C_2H_5OH$ | 28.8 | 40.5 |

### Solubility of Acetanilide in Mixtures of Ethyl Alcohol and Water.

| Wt. Per Cent $C_2H_5OH$ in Solvent. | Results at 25°. (Holleman and Antush, 1894.) Sp. Gr. of Sat. Solution. | Gms. $C_6H_5NH.COCH_3$ per 100 Gms. Sat. Solution. | Results at 30°. (Seidell, 1907.) Sp. Gr. of Sat. Solution. | Gms. $C_6H_5NH.COCH_3$ per 100 Gms. Sat. Solution. |
|---|---|---|---|---|
| 0 | 0.997 | 0.54 | 1.000 | 0.69 |
| 10 | 0.985 | 0.93 | 0.984 | 1.00 |
| 20 | 0.973 | 1.28 | 0.970 | 2.20 |
| 30 | 0.962 | 2.30 | 0.956 | 4.80 |
| 40 | 0.950 | 4.85 | 0.945 | 9.40 |
| 50 | 0.939 | 8.87 | 0.934 | 15.40 |
| 60 | 0.928 | 14.17 | 0.926 | 22.00 |
| 70 | 0.918 | 19.84 | 0.917 | 27.60 |
| 80 | 0.907 | 25.17 | 0.907 | 31.20 |
| 85 | 0.899 | 26.93 | 0.900 | 31.70 |
| 90 | 0.890 | 27.65 | 0.893 | 31.60 |
| 95 | 0.874 | 26.82 | 0.885 | 30.80 |
| 100 | 0.851 | 24.77 | 0.876 | 29.00 |

(See remarks under α Acetnaphthalide, page 705.)

## Solubility of Acetanilide in Mixtures of Water and Alcohols at 20°.

(Gregg-Wilson and Wright, 1928.)

Results for mixtures of:

| Water and Methyl Alcohol | | Water and Ethyl Alcohol | | Water and Propyl Alcohol | |
|---|---|---|---|---|---|
| Wt. % $CH_3OH$ in Aq. Solvent | Gms. $C_8H_9ON$ per 100 gms. Solvent | Wt. % $C_2H_5OH$ in Aq. Solvent | Gms. $C_8H_9ON$ per 100 gms. Solvent | Wt. % $C_3H_7OH$ in Aq. Solvent | Gms. $C_8H_9ON$ per 100 gms. Solvent |
| 0.0 | 0.52 | 0.0 | 0.52 | 0.0 | 0.52 |
| 25.4 | 1.75 | 26.3 | 2.15 | 16.3 | 1.8 |
| 49.8 | 7.25 | 52.5 | 13.7 | 34.5 | 9.3 |
| 71.7 | 23.15 | 74.8 | 29.0 | 54.2 | 18.6 |
| 86.6 | 37.5 | 84.2 | 33.1 | 85.0 | 33.75 |
| 93.5 | 42.1 | 90.4 | 32.3 | 90.0 | 35.4 |
| 96.2 | 43.6 | 95.2 | 31.3 | 95.3 | 28.4 |
| 100.0 | 46.0 | 100.0 | 28.8 | 100.0 | 22.6 |

## Solubility of Acetanilide in Aqueous Solutions of Acetic Acid.

(Bradfield and Williams, 1929.)

The determinations were made by gradually heating mixtures of known weights of the solute and solvent and noting the temperature at which the last trace of solid disappeared. The results were plotted and the values for selected temperatures obtained from the curve.

| Gms. $CH_3COOH$ per 100 gms. Aq. Solvent | Gms. $CH_3CONH.C_6H_5$ dissolved per 100 gms. solvent at: | | | |
|---|---|---|---|---|
| | 20° | 25° | 30° | 35° |
| 0.0 (= $H_2O$) | 0.504 | 0.563 | 0.665 | 0.808 |
| 26.9 | 2.23 | 2.70 | 3.28 | 4.05 |
| 52.4 | 9.82 | 12.2 | 15.3 | 19.2 |
| 76.8 | 31.5 | 38.2 | 46.6 | 56.9 |
| 85.0 | 40.4 | 47.6 | 56.7 | 67.9 |
| 91.3 | 45.4 | 52.5 | 61.2 | 71.6 |
| 99.0 | 46.2 | 52.9 | 60.9 | 70.7 |

## Solubility of Acetanilidine in Aqueous Solutions of Antipyrine and of Pyramidone. (Oliveri-Mendala and Forni, 1925.)

Results for Antipyrine solutions

| at 10°. Gms. per 100 gms. sat. sol. | | at 20°. Gms. per 100 gms. sat. sol. | |
|---|---|---|---|
| Antipyrine. | Acetanilide. | Antipyrine. | Acetanilide. |
| 0.5 | 0.45 | 0.5 | 0.526 |
| 1.0 | 0.50 | 1.0 | 0.597 |
| 2.0 | 0.55 | 2.0 | 0.712 |
| 4.0 | 0.77 | 4.0 | 0.900 |
| 5.0 | 1.03 | 5.0 | 1.043 |
| 10.0 | 1.64 | 10.0 | 1.690 |

Results for Pyramidone solutions

| at 14°. Gms. per 100 gms. sat. sol. | | at 25°. Gms. per 100 gms. sat. sol. | |
|---|---|---|---|
| Pyramidone. | Acetanilide. | Pyramidone. | Acetanilide. |
| 0.5 | 0.43 | 0.5 | 0.699 |
| 1.0 | 0.45 | 1.0 | 0.715 |
| 2.0 | 0.49 | 2.0 | 0.750 |
| 2.495 | 0.51 | 2.495 | 0.761 |
| 4.0 | 0.57 | 4.0 | 0.908 |

100 cc. of aqueous 10.1 per cent sodium salicylate solution dissolve 0.848 gm. acetanilide, and 100 cc. of aqueous 13.9 per cent solution dissolve 0.92 gm. at 20°.

(Oliveri-Mandala, 1926.)

## Solubility of Acetanilide in Several Solvents.

| Solvent. | t°. | Sp. Gr. of Sat. Solution. | Gms. $C_6H_5NH.COCH_3$ per 100 Gms. Sat. Solution. | Authority. |
|---|---|---|---|---|
| Water | 16 | ... | 0.47 | (Greenish and Smith, 1903.) |
| " | 25 | 0.997 | 0.54 | (Holleman and Antush, 1894.) |
| " | 30 | 1.000 | 0.69 | (Seidell, 1907.) |
| Ether | 25 | ... | 2.8 | (Marden and Dover, 1916.) |
| Formic Acid (95%) | 16.8 | 1.121 | 56.74 | (Aschan, 1913.) |
| Acetic Acid (99.5%) | 21.5 | ... | 33.21 | (Seidell, 1907.) |
| Acetone | 30–31 | 0.902 | 31.15 | " |
| Amyl Acetate | " | 0.882 | 10.46 | " |
| Amyl Alcohol | 25 | ... | 14.00 | " |
| Aniline | 30–31 | 1.034 | 19.38 | " |
| Benzene | " | 0.875 | 2.46 | " |
| Benzaldehyde | " | 1.068 | 18.83 | " |
| Toluene | 25 | 0.862 | 0.50 | " |
| Xylene | 32.5 | 0.847 | 1.65 | " |
| Pyridine | 20–25 | ... | 32.7 | (Dehn, 1917.) |
| 50% Aq. Pyridine | " | ... | 35.7 | " |
| Petroleum Ether | about 20 | ... | 0.03 | (Salkower, 1916.) |

100 gms. Carbon tetrachloride dissolve 0.102(0.120) gm. acetanilide at 25°. (Warren, 1933.)

## Solubility of Acetanilide in Several Solvents.

| Solvent. | t°. | Gms. $C_6H_5NH.COCH_3$ per 100 gms. solvent. | Authority. |
|---|---|---|---|
| Glycerol (Density 1.2326) | 20 | 0.93 | (Holm, 1921, 1923.) |
| " ( " 1.2645) | 20 | 1.15 | " |
| Paracymene (b. pt. 176–176.5) | 30 | 7.23 | (Wheeler, 1920.) |
| Ethylalcohol (com. absolute) | 20–23 | 21.3 | (Pucher and Dehn, 1921.) |
| Quinoline | " | 12.67 | " |
| " + $C_2H_5OH$ (Equimol. mixture) | " | 23.69 | " |

## Solubility in Methylalcohol, Ethylalcohol and in Chloroform.

(Speyers, 1902)

| | In $CH_3OH$. | | In $C_2H_5OH$. | | In $CHCl_3$. | |
|---|---|---|---|---|---|---|
| t°. | Sp. Gr. of sat. solution | Gms. $C_6H_5NH.COCH_3$ per 100 gms. $CH_3OH$. | Sp. Gr. of sat. solution. | Gms. $C_6H_5NH.COCH_3$ per 100 gms. $C_2H_5OH$. | Sp. Gr. of sat. solution. | Gms. $C_6H_5NH.COCH_3$ per 100 gms. $CHCl_3$ |
| 0... | 0.860 | 24.0 | 0.842 | 15.5 | 1.503 | 3.9 |
| 10... | 0.864 | 30.0 | 0.844 | 20.0 | 1.475 | 7.5 |
| 20... | 0.875 | 42.0 | 0.850 | 28.0 | 1.440 | 13.0 |
| 30... | 0.892 | 62.0 | 0.860 | 38.0 | 1.398 | 20.0 |
| 40... | 0.911 | 90.0 | 0.874 | 54.0 | 1.354 | 29.0 |
| 50... | 0.932 | 137.0 | 0.895 | 78.0 | 1.314 | 43.0 |
| 60... | 0.957 | 215.0 | 0.920 | 120.0 | 1.272 | 65.0 |

## Solubility of Acetanilide in Phenol, Urethan and in Toluene. (Mortimer, 1923.)

| t°. | In Phenol. Mol. % $C_6H_5NHCOCH_3$ in sat. sol. | In Phenol. Gms. $C_6H_5NHCOCH_3$ per 100 gms. $C_6H_5OH$. | In Urethan. Mol. % $C_6H_5NHCOCH_3$ in sat. sol. | In Urethan. Gms. $C_6H_5NHCOCH_3$ per 100 gms. $NH_2CO_2C_2H_5$. | In Toluene. Mol. % $C_6H_5NHCOCH_3$ in sat. sol. | In Toluene. Gms. $C_6H_5NHCOCH_3$ per 100 gms. $C_6H_5CH_3$. |
|---|---|---|---|---|---|---|
| 0... | .... | ..... | .... | ..... | 0.15 | 0.22 |
| 20... | .... | ..... | .... | ..... | 0.37 | 0.54 |
| 40... | 42.7 | 107.0 | 14.8 | 26.3 | 1.1 | 1.63 |
| 60... | 50.1 | 144.2 | 27.4 | 57.2 | 5.6 | 8.69 |
| 80... | 60.5 | 220.1 | 46.8 | 133.2 | 33.8 | 74.85 |
| 100... | 79.5 | 557.2 | 75.7 | 472.1 | 70.8 | 355.50 |

## Solubility of Acetanilide in Mixtures of Alcohols at 20°.

(Gregg-Wilson and Wright, 1928.)

Results for Mixtures of:

| Methyl and Ethyl Alcohols: Wt. % $CH_3OH$ in Solvent | Gms. $C_8H_9ON$ per 100 gms. Solvent | Ethyl and Propyl Alcohols: Wt. % $C_2H_5OH$ in Solvent | Gms. $C_8H_9ON$ per 100 gms. Solvent | Normal and Iso Propyl Alcohols: Wt. % n $C_3H_7OH$ in Solvent | Gms. $C_8H_9ON$ per 100 gms. Solvent |
|---|---|---|---|---|---|
| 0.0 | 28.8 | 0.0 | 21.8 | 0.0 | 25.9 |
| 17.7 | 31.4 | 19.9 | 23.9 | 24.7 | 25.5 |
| 33.7 | 34.2 | 40.7 | 25.4 | 46.2 | 24.9 |
| 50.3 | 37.2 | 59.1 | 26.4 | 71.2 | 23.4 |
| 71.4 | 40.6 | 79.4 | 27.6 | 83.3 | 22.9 |
| 83.0 | 42.5 | 90.0 | 27.9 | 100.0 | 21.8 |
| 100.0 | 46.2 | 100.0 | 28.8 | | |

## Solubility of Acetanilide in Mixtures of Benzene and Alcohols at 20°.

(Gregg-Wilson and Wright, 1928.)

Results for Mixtures of:

| Benzene and Methyl Alcohol: Wt. % $C_6H_6$ in Solvent | Gms. $C_8H_9ON$ per 100 gms. solvent | Benzene and Ethyl Alcohol: Wt. % $C_6H_6$ in Solvent | Gms. $C_8H_9ON$ per 100 gms. Solvent | Benzene and Propyl Alcohol: Wt. % $C_6H_6$ in Solvent | Gms. $C_8H_9ON$ per 100 gms. Solvent |
|---|---|---|---|---|---|
| 0.0 | 46.2 | 0.0 | 28.8 | 0.0 | 22.6 |
| 21.8 | 52.8 | 20.0 | 33.3 | 18.8 | 27.6 |
| 42.5 | 54.5 | 41.7 | 35.7 | 42.0 | 29.6 |
| 62.8 | 50.1 | 63.8 | 31.75 | 58.0 | 28.2 |
| 81.5 | 35.1 | 83.8 | 21.1 | 83.0 | 17.5 |
| 100.0 | 1.08 | 100 | 1.08 | 100.0 | 1.08 |

## Solubility of Acetanilide in Mixtures of Solvents at 25°.

(Mahieu, 1938.)

Results for mixtures of:

$(CH_3)_2CO + C_6H_6$

| Wt. % $C_6H_6$ in Solvent | Gms. $C_8H_9ON$ per 100 gms. Solvent |
|---|---|
| 0 | 39.89 |
| 31.4 | 32.5 |
| 52.6 | 24.96 |
| 75.1 | 16.38 |
| 100.0 | 1.40 |

$CS_2 + C_6H_5NO_2$

| Wt. % $C_6H_5NO_2$ in Solvent | Gms. $C_8H_9ON$ per 100 gms. Solvent |
|---|---|
| 0.0 | 0.23 |
| 27.5 | 2.98 |
| 52.2 | 8.49 |
| 74.1 | 9.73 |
| 87.0 | 8.86 |
| 100.0 | 7.60 |

$C_6H_5NH_2 + C_6H_5NO_2$

| Wt. % $C_6H_5NH_2$ in Solvent | Gms. $C_8H_9ON$ per 100 gms. Solvent |
|---|---|
| 0.0 | 7.60 |
| 22.2 | 22.1 |
| 48.9 | 23.4 |
| 67.2 | 22.5 |
| 100.0 | 21.07 |

$C_6H_5NH_2 + C_6H_{12}$ (50°)

| Wt. % $C_6H_5NH_2$ in Solvent | Gms. $C_8H_9ON$ per 100 gms. Solvent |
|---|---|
| 0.0 | 0.33 |
| 24.6 | 3.02 |
| 53.1 | 39.4 |
| 78.2 | 54.7 |
| 100.0 | 46.8 |

$(CS_2 + (CH_3)_2CO$

| Wt. % $(CH_3)_2CO$ in Solvent | Gms. $C_8H_9ON$ per 100 gms. Solvent |
|---|---|
| 0.0 | 0.23 |
| 23.7 | 18.9 |
| 49.1 | 36.3 |
| 74.0 | 38.6 |
| 100.0 | 39.89 |

$(C_2H_5)_2O + CHCl_3$

| Wt. % $(C_2H_5)_2O$ in Solvent | Gms. $C_8H_9ON$ per 100 gms. Solvent |
|---|---|
| 0.0 | 20.48 |
| 24.4 | 7.40 |
| 51.5 | 4.17 |
| 74.9 | 3.15 |
| 100.0 | 2.45 |

$H_2O + C_3H_7OH$

| Wt. % $H_2O$ in Solvent | Gms. $C_8H_9ON$ per 100 gms. Solvent |
|---|---|
| 0.0 | 26.93 |
| 13.1 | 38.4 |
| 34.4 | 36.05 |
| 53.8 | 18.05 |
| 75.6 | 5.99 |
| 100 | 0.61 |

$CS_2 + CH_3OH$

| Wt. % $CH_3OH$ in Solvent | Gms. $C_8H_9ON$ per 100 gms. Solvent |
|---|---|
| 0.0 | 0.23 |
| 23.8 | 50.3 |
| 46.8 | 76.7 |
| 79.4 | 67.5 |
| 100.0 | 54.8 |

100 gms. sat. solution of Acetanilide in liquid Ammonia contain 48 gms. $C_8H_9ON$ at ? t°. (De Carli, 1927.)

SOLUBILITY OF ACETANILIDE IN MIXTURES OF ETHER AND CHLOROFORM AND OF ACETONE AND BENZENE AT 25°. (Marden and Dover, 1916.)

| Results for Ether-Chloroform Mixtures. | | Results for Acetone-Benzene Mixture. | |
|---|---|---|---|
| Wt. Per Cent $CHCl_3$ in Mixed Solvent. | Gms. $C_6H_5NH.COCH_3$ per 100 Gms. Mixed Solvent. | Wt. Per Cent $C_6H_6$ in Mixed Solvent. | Gms. $C_6H_5NH.COCH_3$ per 100 Gms. Mixed Solvent. |
| 100 | 17.7 | 100 | 1.36 |
| 90 | 11.7 | 90 | 6.78 |
| 80 | 8.2 | 80 | 13.0 |
| 70 | 6.2 | 70 | 20.0 |
| 60 | 4.95 | 60 | 29.2 |
| 50 | 4.25 | 50 | 30.0 |
| 40 | 3.8 | 40 | 30.5 |
| 30 | 3.5 | 30 | 33.0 |
| 20 | 3.25 | 20 | 36.0 |
| 10 | 3.05 | 10 | 45.7 |
| 0 | 2.9 | 0 | 39.4 |

DISTRIBUTION OF ACETANILIDE BETWEEN IMMISCIBLE SOLVENTS AT 25°.

Conc. $C_6H_5NH.COCH_3$ in Benzene layer ÷ Conc. in $H_2O$ layer = 1.65. (Farmer and Warth, 1904.)

" " " Chloroform " ÷ Conc. in $H_2O$ layer = 7.75. (Marden, 1914.)

" " " Ether " ÷ Conc. in $H_2O$ layer = 2.98. (Marden, 1914.)

Freezing-point data are given for mixtures of Acetanilide and:

Aniline + Allyl phenyl thio urea(13)
Antipyrine(2)(5a)
" + Phenacetine(5)
" + Salicylic acid(8)
Benzoic acid(12)(5a)
Chloral hydrate(1)
Dinitro benzene(3)
Diphenyl amine(5a)
Ethyl Urethan(5a)
Hydroquinone(5a)
" + Resorcinol(8)
Naphthol + Urea(9)
Nitraniline(3)
Nitro acetanilide(11)
Naphthylamine(5a)
Menthol(5a)
Phenacetine(10)(1)(5a)
" + Antipyrine(5)
" + Resorcinol(5)
Dinitro phenol(3)(14)
Phenacetine + Sulfonal(5)
" + Urea(5)
Phenol(1)
Propioanilide(4)(14)
Pyramidon(1)
Quinine(5a)
Resorcinol(1)
" + Hydroquinone(8)
" + Phenacetine(5)
Salicylic acid + Antipyrine(8)
" " + Urea(9)
Salipyrine(5a)
" + Sulfonal(6)
Salol(5a)
Sulfonal(5a)
Thymol(1)(7)
Urea(5a)
" + Naphthol(9)
" + Phenacetine(5)
" + Salicylic acid(9)

(1) Angeletti, 1927; (2) Comanducci, 1912; (3) Crompton and Whiteby, 1895; (4) Gilbert and Clark, 1927; (5) Hrynakowski, 1934; (5a) Hrynakowski and Adamanis, 1933a; (6) Hrynakowski and Staszewski, 1936; (7) Hrynakowski and Szmyt, 1935; (8) Hrynakowski and Szmyt, 1935b; (9) Hrynakowski and Szmyt, 1935c; (10) Kitran, 1924; (11) Küster, 1891; (12) Puschin and Wilowitsch, 1925; (13) Schischokin, 1930; (14) Tammann and Betschvar, 1926.

**PHENYL AMINO ACETIC ACID** $CH(NH_2)(C_6H_5)COOH$.

The eutectic temperature of a mixture of active phenyl amino acetic acid and water is 0.07°. That for a mixture of the inactive compound compound and water is 0.13°. (Timmermans and Motiuk, 1932.)

Results are also given for the freezing-points of ternary mixtures composed of phenylamino acetic acid + phenyl glycolic acid + water.

**METHYL ANTHRANILIC ACID** $(CH_3)NHC_6H_4COOH$.

DISTRIBUTION OF METHYL ANTHRANILIC ACID AT 25° BETWEEN:
(Smith and White, 1929.)

| Water and Chloroform | | Water and Toluene | |
|---|---|---|---|
| Gm. Mols. $C_8H_9O_2$ per liter | | Gm. Mols. $C_8H_9O_2$ per liter | |
| $H_2O$ layer | $CHCl_3$ layer | $H_2O$ layer | $C_6H_5CH_3$ layer |
| 0.00099 | 0.0125 | 0.000924 | 0.00317 |
| 0.00108 | 0.0143 | 0.00112 | 0.00370 |
| 0.00119 | 0.0162 | 0.00132 | 0.00436 |
| 0.00132 | 0.0191 | 0.00158 | 0.00502 |
| 0.00145 | 0.0218 | 0.00185 | 0.00580 |
| 0.00158 | 0.0257 | 0.00220 | 0.00682 |

**AMINO ACETOPHENONE** $CH_3COC_6H_4NH_2$.

Freezing-point data are given for mixtures of p amino aceto phenone and:

1.2.4 Chloro di nitro benzene (Giua, Marcellino and Curti, 1920); Cinnamylidene aceto phenone (Giua, 1925); Tri nitro anisole (Giua, 1931); and 2.4.6-Tri nitro toluene (Giua, 1917.)

**METHYL AMINO BENZOATE** m and p $NH_2C_6H_4COOCH_3$.

Freezing-point data are given for mixtures of:

Methyl amino benzoates + Antipyrine (Pfeiffer and Seydel, 1928b.)
" " " + Pyramidon " " "
" " " + Sarcosine anhydride (Pfeiffer and Seydel, 1928b;) and Pfeiffer, Angern and Wang, 1927.)

**BROMO, CHLORO NITRO DI METHYL ANILINES** $BrNO_2(CH_3)_2C_6HNH_2$.

Freezing-point data for mixtures of Bromo nitro di methyl anilines and for mixtures of Chloro nitro di methyl anilines are given by Clemo and Smith, 1928.

**ANIS ALDOXIMES** $CH_3OC_6H_4CH{:}NOH$.

Freezing-point data for mixtures of the cis and trans anis aldoximes are given by Skau and Saxton, 1933.

**NITRO PHENETOL** $NO_2C_6H_4OC_2H_5$.

Freezing-point data for mixtures of nitro phenetol with nitro erythritol and with nitro mannitol are given by Urbanski, 1933, 1934.

**XYLENE** $C_6H_4(CH_3)_2$.

### Solubility of Xylene in Water.

The solubility of xylene in water is given by Horiba, 1917, as 0.018 but the isomer used, the temperature or the terms in which the result is expressed, are not defined.

Determinations of the solubility of xylene (Isomer?) in superheated water were made by Jaeger, 1923. A large shaking autoclave of more than two liters capacity was used. A measured volume of the saturated solution was cooled and after it had separated into two layers, the volume of xylene was measured.

| t°..... | 150°. | 200°. | 250°. |
|---|---|---|---|
| Cc. Xylene per 100 cc. $H_2O$..... | 0.1 | 0.35 | 1.1 |

### Reciprocal Solubility of Xylene and Water.

(Uspenski, 1929.)

| t° | Gms. $C_6H_4(CH_3)_2$ per 100 gms. sat. sol. in $H_2O$ | Gms. $H_2O$ per 100 gms. sat. sol. in $C_6H_4(CH_3)_2$ |
|---|---|---|
| 10 | 0.0076 | 0.0185 |
| 25 | 0.0130 | 0.0384 |

100 gms. sat. solution of commercial xylene in 92 wt. per cent ethyl alcohol contain 83.4 gms. xylene at 15°. (Ormandy and Craven, 1921.)

100 gms. sat. solution of *hexahydro xylene* in 92 wt. per cent ethyl alcohol contain 26.4 gms. of the compound at 15°. (Ormandy and Craven, 1921.)

Results for the reciprocal solubility of Xylene and Sulfur are given by Hammick and Holt, 1927.

Freezing-point data for mixtures of *m* and *p* xylene are given by Nakatsuchi, 1926.

Freezing-point data are given for mixtures of Xylenes and:

Acetic acid(3)
Benzene(2)(3)
Bromo toluene(3)
Ethyl bromide(3)
Ethyl succinimide(3)
Phenol(3)
Resorcinol(1)
Toluene(2)
Veratrole(3)

(1) Campetti, 1917; (2) Nakatsuchi, 1926; (3) Paterno and Ampola, 1897.

**XYLENOL** 1.3.4, $C_6H_3.(CH_3)_2.OH$.

### Miscibility of Aqueous Alkaline Solutions of Xylenol with Several Organic Compounds, Insoluble in Water.

(Scheuble, 1907.)

To 5 cc. portions of aq. KOH solution (250 gms. per liter) were added the given amounts of the aq. insoluble compound from a buret and the xylenol, dropwise, until solution occurred. Temperature not stated.

| Composition of Homogeneous Solution. | | |
|---|---|---|
| cc. Aq. KOH. | cc. Aq. Insol. Cmpd. | Gms. Xylenol. |
| 5 | 2 (= 1.64 gms.) Octyl Alcohol (1) | 1 |
| 5 | 5 (= 4.10 " ) " | 1.7 |
| 5 | 2 (= 1.74 " ) Toluene | 4.1 |
| 5 | 3 (= 2.61 " ) " | 5 |

(1) The normal secondary octyl alcohol, *i.e.*, the so-called capryl alcohol, $CH_3(CH_2)_5.CH(OH)CH_3$.

Freezing-point data are given for mixtures of Xylenols and:

Cineole (Morgan and Pettet, 1935.)
Tetra methyl phthalan (Bennett and Wain, 1936.)
Xylidenes (Morgan and Pettet, 1935.)

## ETHYL BENZENE $C_6H_5C_2H_5$.

100 gms. sat. solution of ethyl benzene in $H_2O$ contain 0.014 gm. $C_6H_5C_2H_5$ at 15°. (Führer, 1924.)

## ETHYL PHENOLS o and p $C_2H_5C_6H_4OH$.

Freezing-point data for mixtures of ethyl phenols with cineole and xylidenes are given by Morgan and Pettet, 1935.

## CARBAMIDES (Ureas) $C_8H_{10}ON_2$.

Solubility in Several Solvents. (Walker and Wood. 1898.)

*as* Methyl phenyl carbamide (m. pt. 82°), benzyl carbamide (m. pt. 149°). *o* tolyl carbamide (m. pt. 185°) and *p* tolyl carbamide (m. pt. 173°).

| Solvent. | t°. | Gms. Each Carbamide Separately per 100 cc. Sat. Solution. | | | |
|---|---|---|---|---|---|
| | | *as* Methyl Phenyl. | Benzyl. | *p* Tolyl. | *o* Tolyl |
| Water | 45 | 74 | 1.71 | 0.307 | 0.251 |
| Acetone | 23 | 29.4 | 3.10 | 2.66 | 0.462 |
| Ether | 22.5 | 2.28 | 0.053 | 0.062 | 0.0162 |
| Benzene | 44.2 | 12.4 | 0.0597 | 0.043 | 0.0155 |

## Acetyl PHENYLENE DIAMINES *o*, *m* and *p* $C_6H_4NH_2.NHCOCH_3$.

Solubility of Each Separately in Water. (Sidgwick and Neill, 1923.)

The determinations were made by the synthetic method.

Results for the Ortho compound.

| t°. | Gms. $C_6H_4NH_2.NHCOCH_3$ (*o*) per 100 gms. sat. sol. |
|---|---|
| 7.2..... | 3.40 |
| 22.0..... | 12.05 |
| 33.5..... | 22.32 |
| 42.1..... | 31.95 |
| 50.4..... | 41.64 |
| 59.1..... | 51.73 |
| 69.9..... | 64.10 |
| 78.2..... | 71.72 |
| 88.1..... | 79.22 |
| 99.0..... | 85.80 |
| 115.4..... | 92.23 |
| 144.8..... | 100.0 |

Results for the Meta compound.

| t°. | Gms. $C_6H_4NH_2.NHCOCH_3$ (*m*) per 100 gms. sat. sol. |
|---|---|
| 48.7..... | 9.05 |
| 82.9..... | 18.12 |
| 110.1..... | 28.20 |
| 132.9..... | 44.13 |
| 144.2..... | 53.34 |
| 156.3..... | 63.56 |
| 167.0..... | 71.10 |
| 181.9..... | 79.34 |
| 204.4..... | 86.73 |
| 235.8..... | 94.15 |
| 279.0..... | 100.0 |

Results for the Para compound.

| t°. | Gms. $C_6H_4NH_2.NHCOCH_3$ (*p*) per 100 gms. sat. sol |
|---|---|
| 56.8..... | 6.50 |
| 86.3..... | 18.63 |
| 92.1..... | 27.63 |
| 93.7..... | 34.27 |
| 96.5..... | 42.82 |
| 98.6..... | 49.17 |
| 103.2..... | 60.15 |
| 107.1..... | 69.35 |
| 112.6..... | 76.50 |
| 119.2..... | 81.74 |
| 144.0..... | 94.13 |
| 160.5..... | 100.00 |

SOLUBILITY OF *o*, *m* AND *p* MONOACETYL PHENYLENE DIAMINES IN BENZENE.
(Sidgwick and Neill, 1923.)

| Ortho compound. | | Meta compound. | | Para compound. | |
|---|---|---|---|---|---|
| t°. | Gms. $C_6H_4NH_2.NHCOCH_3$ (*o*) per 100 gms. sat. sol. | t°. | Gms. $C_6H_4NH_2.NHCOCH_3$ (*m*) per 100 gms. sat. sol. | t°. | Gms. $C_6H_4NH_2.NHCOCH_3$ (*p*) per 100 gms. sat. sol. |
| 29.9..... | 4.13 | 56.5..... | 3.13 | 116.2..... | 7.15 |
| 53.6..... | 11.21 | 107.1..... | 6.72 | 180.8..... | 17.36 L |
| 73.5..... | 20.24 | 163.2..... | 12.24 | 187.8..... | 30.12 L |
| 84.2..... | 27.36 | 228.5..... | 29.75 L | 188 crit. t.... | – |
| 92.4..... | 35.27 | 263.4..... | 39.10 L | 186.3..... | 41.23 L |
| 99.8..... | 43.04 | 265.5..... | 44.31 L | 181.3..... | 51.70 L |
| 106.7..... | 51.50 | 266 crit. t.... | – | 170.0..... | 59.95 L |
| 117.8..... | 65.12 | 265.1..... | 49.23 L | 163.5..... | 63.07 L |
| 127.5..... | 77.76 | 257.6..... | 57.63 L | 155.9..... | 67.66 L |
| 135.2..... | 88.05 | 227.8..... | 68.90 L | 150.1..... | 71.05 L |
| 144.8..... | 100.00 | 201.9..... | 74.65 L | 147.1..... | 72.71 L |
| | | 193.4..... | 76.17 L | 146.8..... | 73.90 L |
| | | 188.4..... | 76.86 L | 146.8 tr. pt.. | 74.0 L + S |
| | | 184.9 tr. pt.. | 77.5 L + S | 147.3..... | 74.62 |
| | | 185.4..... | 77.55 | 148.2..... | 76.85 |
| | | 187.1..... | 78.61 | 148.7..... | 78.41 |
| | | 190.0..... | 80.19 | 149.8..... | 80.70 |
| | | 203.1..... | 85.50 | 152.0..... | 86.19 |
| | | 221.9..... | 91.06 | 156.8..... | 93.89 |
| | | 279.0..... | 100.00 | 160.5..... | 100.00 |

L, indicates two liquid layers.
S, indicates solid phenylene diamine.

## NITROSO ETHYL ANILINE p $NOC_6H_4NH(C_2H_5)$.

Freezing-point data for mixtures of p nitroso ethyl aniline and p nitro ethyl aniline are given by Jaeger and van Kregten, 1912.

## NITROSO DIMETHYL ANILINE $NO.C_6H_4N(CH_3)_2$.

Freezing-point data are given for mixtures of Nitroso dimethyl aniline +

Acetamide(4)
Acridine(4)
Aniline(3)
Benzamide(4)(5)(6)
Naphthylamine(3)(4)(6)
Nitro nitroso benzene(2)
Phenol(1)(3)
Phenylene diamines(4)
Pyridine(4)
Quinoline(4)
Toluidine(1)(3)
Xylidene(3)

(1) Bernoulli and Veillon, 1932; (2) Hammick, Edwards, Illingsworth and Snell, 1933 ; (3) Kremann, 1904; (4) Kremann and Wlk, 1919; (5) Puschin and Rikovski, 1930; (6) Rheinboldt, Henning and Kircheisen, 1925.

## VERATROLE $C_6H_4(OCH_3)_2$1,2.

Freezing-point data for mixtures of Veratrole with bromo toluene and p xylene are given by Paterno and Ampola, 1897.

## DIMETHOXY BENZENE $C_6H_4(OCH_3)_2$ 1,4.

Freezing-point data for mixtures of 1.4 Dimethoxy benzene and:

| | |
|---|---|
| m Di nitro benzene | (Giua and Marcellino, 1920.) |
| 1.2.4-Di nitro toluene | " " " |
| 2.4.6-Tri nitro phenol | " " " |
| 2.4.6-Tri nitro toluene | " " " |
| Nitro mannitol | (Urbanski, 1934.) |

## p NITRO DIMETHYL ANILINE $NO_2C_6H_4N(CH_3)_2$.

Results for the solubility of p Nitro dimethyl aniline and of 4:4' Bis methyl nitroso amino diphenyl methane in aqueous solutions of hydrochloric acid at o°, determined by a precipitation method, are given by Donald and Reade, 1935.

## p NITRO ETHYL ANILINE $NO_2C_6H_4NH(C_2H_5)$.

Freezing-point data for mixtures of p Nitro ethyl aniline and nitroso ethyl aniline are given by Jaeger and van Kregten, 1912.)

## CAFFEINE $C_5H(CH_3)_3N_4O_2.H_2O$.

SOLUBILITY IN WATER.

(Average curve from results of Zalai, 1910; Pellini, 1910, and U.S.P., 8th Ed.)

| t°. | Gms. $C_5H(CH_3)_3N_4O_2$ per 100 Gms. $H_2O$. | t°. | Gms. $C_5H(CH_3)_3N_4O_2$ per 100 Gms. $H_2O$. |
|---|---|---|---|
| 0 | 0.6 | 40 | 4.64 |
| 15 | 1.0 | 50 | 6.75 |
| 20 | 1.46 | 60 | 9.7 |
| 25 | 2.13 | 70 | 13.5 |
| 30 | 2.8 | 80 | 19.23 |

SOLUBILITY OF CAFFEINE IN WATER.

(Chambon, Bouvier, and Duron, 1937.)

| t° | Gms. $C_5H(CH_3)_3N_4O_2$ per 100 gms. $H_2O$ |
|---|---|
| 2 | 0.735 |
| 37 | 3.85 |
| 57 | 11.29 |
| 85 | 37.6 |
| 90 | 83.5 |

(Oliveri-Maudala and Irrera, 1930.)

| t° | Gms. $C_5H(CH_3)_3N_4O_2$ per 100 gms. sat. sol. |
|---|---|
| 15 | 1.230 |
| 25 | 2.122 |
| 35 | 3.560 |

$C_8H_{10}O_2$

## CAFFEINE $C_5H(CH_3)_3N_4O_2.H_2O$.

### Equilibrium in the Binary System Caffeine-Water, Determined by the Thermic Method.

(Kremann and Janetzky, 1923.)

The equilibrium temperatures in known mixtures of the two constituents were determined either by the freezing-point method, by observation of the appearance or disappearance of the last crystals, or by means of the points of arrest or change of direction in time-cooling curves.

| t° of primary crystallization. | Wt. Per cent of $C_5H(CH_3)_3N_4O_2$ in mixture. | Solid Phase | t° of primary crystallization. | Wt. Per cent of $C_5H(CH_3)_3N_4O_2$ in mixture | Solid Phase. |
|---|---|---|---|---|---|
| — 0.2 | 0.5 | Ice | 54.5 | 20.0 | $C_5H(CH_3)_3N_4O_2.H_2O$ |
| — 0.3 | 1.9 | » | 58.5 | 25.0 | » |
| — 0.4 (Eutec.) | 4.0 | »+$C_5H(CH_3)_3N_4O_2.H_2O$ | 61.0 | 31.0 | »+$C_5H(CH_3)_3N_4O_2$ |
| +13.0 | 4.5 | $C_5H(CH_3)_3N_4O_2.H_2O$ | 67.2 | 35.5 | $C_5H(CH_3)_3N_4O_2$ |
| 32.5 | 7.2 | » | 73.0 | 40.0 | » |
| 40.5 | 9.6 | » | 81.5 | 45.6 | » |
| 49.5 | 15.0 | » | 100.0 | 59.0 | » |

100 gms. sat. solution of caffeine in water contain 1.224 gms. caffeine at 15° and 2.119 gms. at 25°. (Oliveri-Mandala, 1926.)

100 cc. sat. solution of hydrated caffeine in water contain 2.071 gms. caffeine at 25°. (Emery and Wright, 1921

### Solubility of Caffeine in Aqueous Solutions of Salts at 22°.

(Zipf, 1930.)

| Aq. Solvent 0.1 normal solution of: | Gms. $C_5H(CH_3)_3N_4O_2$ per 100 gms. sat. sol. | Aq. Solvent 0.1 normal solution of: | Gms. $C_5H(CH_3)_3N_4O_2$ per 100 gms. sat. sol. |
|---|---|---|---|
| Lithium hexophane | 5.652 | Sodium toluene p sulfonate | 2.634 |
| Sodium Salicylate | 4.392 | Sodium benzoate | 2.616 |
| Sulfo salicylic acid | 2.943 | Sodium Iodide | 1.976 |
| Sodium sulfo salicylate | 2.595 | Sodium Rhodanate | 1.992 |
| Potassium guaiacol sulfonate | 3.047 | Hydrochloric acid | 1.669 |
| Toluene p sulfonic acid | 2.73 | Sodium Chloride | 1.474 |

The author also gives the distribution coefficients of caffeine between the above aqueous solutions and chloroform.

### Solubility of Caffeine in Aqueous Solutions of Sodium Benzoate.

(Chambon, Bouvier, and Duron, 1937.)

| t° | Gms. per 100 gms. $H_2O$ | | Solid Phase | t° | Gms. per 100 gms. $H_2O$ | | Solid Phase |
|---|---|---|---|---|---|---|---|
| | $C_5H(CH_3)_3N_4O_2$ | $C_6H_5COONa$ | | | $C_5H(CH_3)_3N_4O_2$ | $C_6H_5COONa$ | |
| 37 | 3.85 | 0.0 | $C_5H(CH_3)_3N_4O_2H_2O$ | 83 | 37.64 | 0.0 | $C_5H(CH_3)_3N_4O_2H_2O$ |
| " | 11.85 | 7.25 | " | " | 46.34 | 8.35 | " |
| " | 58.1 | 78.92 | "+$C_6H_5COONa$ | 87 | 51.04 | 0.0 | " |
| " | 0.0 | 59.9 | $C_6H_5COONa$ | " | 52.3 | 9.17 | " |
| 57 | 11.29 | 0.0 | $C_5H(CH_3)_3N_4O_2.H_2O$ | 90 | 83.5 | 0.0 | " |
| " | 22.6 | 7.5 | " | " | 64.0 | 7.4 | " |
| " | 34.4 | 15.8 | " | " | 93.2 | 99.4 | "+$C_6H_5COONa$ |
| | | | | | 0.0 | 76.5 | $C_6H_5COONa$ |

## Solubility of Caffeine in Aqueous Solutions of Antipyrine.

(Oliveri-Mandala and Irrera, 1930.)

| Results at 15° | | Results at 25° | | Results at 35° | |
|---|---|---|---|---|---|
| Gms. per 100 gms. sat. sol. | | Gms. per 100 gms. sat. sol.. | | Gms. per 100 gms. sat. sol. | |
| Antipyrine | Caffeine | Antipyrine | Caffeine | Antipyrine | Caffeine |
| 4.824 | 2.130 | 4.824 | 3.140 | 4.824 | 4.632 |
| 9.814 | 2.482 | 9.814 | 3.844 | 9.814 | 6.871 |
| 13.675 | 3.173 | 13.675 | 4.767 | 13.675 | 8.279 |

## Solubility of Caffeine in Aqueous Solutions of Chloral Hydrate.

(Oliveri-Mandala, 1926.)

| Results at 15°. | | Results at 25°. | |
|---|---|---|---|
| Gms. per 100 gms. sat. sol. | | Gms. per 100 gms. sat. sol. | |
| $CCl_3.CH(OH)_2$. | $C_8H(CH_3)_3N_4O_2$. | $CCl_3.CH(OH)_2$. | $C_8H(CH_3)_3N_4O_2$. |
| 5.216 | 2.173 | 5.216 | 3.228 |
| 7.124 | 2.992 | 7.124 | 5.236 |
| 8.924 | 4.096 | 8.924 | 4.897 |

100 gms. of sat. solution of caffeine in 6.667 % aqueous sodium benzoate solution contain 8.321 gms. caffeine at 25°. (Oliveri-Mandala, 1926.)

## Solubility of Hydrated Caffeine in Various Aqueous Solutions at 25°.

(Emery and Wright, 1921.)

| Aqueous solution. | Gms. $C_8H(CH_3)_3N_4O_2$ per 100 cc. sat. sol. | Aqueous solution. | Gms. $C_8H(CH_3)_3N_4O_2$ per 100 cc. sat. sol. |
|---|---|---|---|
| 1.0 Normal sulfuric acid..... | 0.3356 | 1.0 Normal sodium salicylate.. | 2.222 |
| 1.0 » citric acid..... | 0.6412 | 0.1 » » .. | 0.492 |
| 1.0 » potassium bromide.. | 0.2136 | 1.0 » sodium benzoate.. | 1.528 |
| 2.5 » » » .. | 0.2036 | 0.1 » » » .. | 0.342 |

100 gms. Glycerol of $d = 1.2326$ (86.5 %) dissolve 0.59 gms. caffeine at 20°. (Holm, 1921-1922.)
100 gms. » $d = 1.2645$ (98.5 %) » 0.47 » » »

## Distribution of Caffeine between Water and Chloroform. (Marden, 1914.)

| Grams Caffeine in: | | Ratio of Caffeine in Equal Vols. $H_2O$ and $CHCl_3$. |
|---|---|---|
| 105 cc. $H_2O$ Layer. | 50 cc. $CHCl_3$ Layer. | |
| 0.0090 | 0.0563 | 0.0456 |
| 0.0180 | 0.1048 | 0.0492 |
| 0.0291 | 0.1770 | 0.0470 |

## Distribution of Caffeine at 25° Between :

(Emery and Wright. 1921.)

### Water and Chloroform.

| Gms. Caffeine per 100 cc. | |
|---|---|
| Aq. layer. | $CHCl_3$ layer. |
| 0.0084 | 0.1916 |
| 0.0172 | 0.3828 |
| 0.0538 | 0.9472 |
| 0.1260 | 1.8740 |
| 0.44 | 4.56 |
| 1.35 | 8.65 |

### 1.0 Normal Aq. $H_2SO_4$ and $CHCl_3$.

| Gms. Caffeine per 100 cc. | |
|---|---|
| Aq. layer. | $CHCl_3$ layer. |
| 0.0186 | 0.1814 |
| 0.0384 | 0.3618 |
| 0.1060 | 0.8940 |
| 0.2264 | 1.7736 |
| 0.693 | 4.307 |
| 1.834 | 8.166 |

### 1.0 Normal Aq. KBr and $CHCl_3$.

| Gms. caffeine per 100 cc. | |
|---|---|
| Aq. layer. | $CHCl_3$ layer. |
| 0.0067 | 0.1933 |
| 0.0164 | 0.3836 |
| 0.0496 | 0.9504 |
| 0.118 | 1.8820 |
| 0.433 | 4.567 |
| 1.329 | 8.671 |

### Distribution of Caffeine at 25° Between : (Emery and Wright, 1921.)

| 0.1 Normal Sodium Salicylate and Chloroform. | | 0.1 Normal Sodium Benzoate and Chloroform. | |
|---|---|---|---|
| Gms. Caffeine per 100 cc. | | Gms. Caffeine per 100 cc. | |
| Aq. layer. | $CHCl_3$ layer. | Aq. layer. | $CHCl_3$ layer. |
| 0.0292 | 0.1708 | 0.0144 | 0.1856 |
| 0.0608 | 0.3392 | 0.0304 | 0.3696 |
| 0.1624 | 0.8376 | 0.0848 | 0.9152 |
| 0.3412 | 1.6588 | 0.1872 | 1.8128 |
| 0.9830 | 4.017 | 0.625 | 4.375 |
| 2.367 | 7.633 | 1.751 | 8.249 |

The authors also give data upon the effect of temperature, small amounts of alcohol, acid, and other substances in solution, upon the distribution of caffeine between water and chloroform. Although the results are expressed in terms of percentage of recovery by extracting caffeine from aqueous solutions with chloroform, they can all be calculated, as have the above, to the form here shown.

### Distribution of Caffeine and of Ethoxy Caffeine Between Water or Serum and Olive Oil. (Aiello, 1921.)

| Immiscible solvents. | Results for : | t°. | Gms. Caffeine or of Ethoxy Caffeine per 100 cc. Aq. layer ($a$) | Oil layer ($o$) | $\frac{o}{a}$. |
|---|---|---|---|---|---|
| Water and olive oil..... | Caffeine | 15 | 0.651 | 0.349 | 0.53 |
| " " ..... | " | 16 | 0.695 | 0.315 | 0.44 |
| " " ..... | " | 17 | 0.725 | 0.275 | 0.37 |
| " " ..... | Ethoxy Caffeine | ? | 0.107 | 0.193 | 1.80 |
| " " ..... | " | ? | 0.111 | 0.189 | 1.70 |
| Horse serum and olive oil. | Caffeine | 18 | 1.150 | 0.292 | 0.25 |
| " " | " | 20 | 1.358 | 0.145 | 0.10 |
| " " | Ethoxy Caffeine | 19 | 0.135 | 0.036 | 0.26 |
| " " | " | 20 | 0 151 | 0.029 | 0.19 |

100 cc. Horse serum dissolve 1.442 gms. caffeine at 18° and 1.503 gms. at 20°.
" " " 0.171 gms. ethoxy caffeine at 19° and 0.180 gms. at 20°.

### Solubility of Caffeine in Organic Solvents.

| Solvent. | t°. | Gms. $C_8H(CH_3)_3N_4O_2$ per 100 Gms. Solvent. | Solvent. | t°. | Gms. $C_8H(CH_3)_3N_4O_2$ per 100 Gms. Solvent. |
|---|---|---|---|---|---|
| Ethyl Alcohol | 25 | 1.32 (2) | Carbon Tetrachloride | 18 | 0.09 (4) |
| " " | 25 | 1.88 (1) | | 20 | 0.26 (6) |
| " " | 60 | 5.85 (1) | | b.pt. | 0.70 (4) |
| Methyl " | 25 | 1.14 (2) | Chloroform | 17 | 12.9 (5) |
| Amyl " | 25 | 0.50 (3) ($d_{25}$=0.810) | " | 25 | 12.3 (1) |
| Amyl Acetate | 30.5 | 0.72 (3) ($d_{30}$=0.862) | " | 25 | 11.92 (2) |
| Acetic Acid (99.5%) | 21.5 | 2.6 (3) | " | b.pt. | 15.63 (4) |
| Acetone | 30.5 | 2.32 (3) ($d_{30}$=0.832) | Ether | 18 | 0.12 (4) |
| Aniline | 30.5 | 29.4 (3) ($d_{30}$=1.080) | " | 25 | 0.27 (1) |
| Benzaldehyde | 30.5 | 13.1 (3) ($d_{30}$=1.087) | " | b.pt. | 0.30 (4) |
| Benzene | 18.0 | 0.91 (4) | Trichlorethylene | 15 | 0.76 (7) |
| " | 25.0 | 1.16 (2) | Dichlorethylene | 15 | 1.82 (7) |
| " | 30.5 | 1.23 (3) ($d_{30}$=0.875) | Pyridine | 20–25 | 34.39 (8) |
| Carbon Disulfide | b.pt. | 5.29 (4) | 50% Aq. Pyridine | " | 11.12 (8) |
| | 17 | 0.06 (5) | Toluene | 25 | 0.58 (3) ($d_{25}$=0.861) |
| | | | Xylene | 32.5 | 1.13 (3) ($d_{32}$=0.847) |

(1) = U. S. P.; (2) = Schaefer, 1913; (3) = Seidell, 1907; (4) = Göckel, 1898; (5) = Commaille, 1875 (6) = Gori, 1913; (7) = Wester and Bruins (1914); (8) = Dehn, 1917.

Data for the solubility of caffeine in mixtures of alcohol and chloroform and alcohol and benzene are given by Schaefer (1913).

Freezing-point data are given for mixtures of:

Caffeine and antipyrine (Kremann and Janetzky, 1932.)
" " salicylic acid (Regenbogeu and Schoorl, 1924.)

### Solubility of Caffeine in Several Solvents.

| Solvent. | t°. | Gms. Caffeine per 100 gms. solvent. | Authority. |
|---|---|---|---|
| Abs. alcohol | 20-25 | 1.88 | (Pucher and Dehn, 1921.) |
| Quinoline | » | 3.56 | » |
| Equi. mol. mixture of alcohol + quinoline. | » | 3.93 | » |
| Para cymene (b. pt. 176–176.5) | 25 | 0.76 | (Wheeler, 1920.) |
| » | 30 | 1.10 | » |
| » | 100 | 1.74 | » |
| » | 175 | 15.58 | » |

## PICRATE OF NITRO PHENYL DIMETHYL SULFONIUM (and Selenium) $C_8H_{10}O_2NS$.

### Solubility of the Isomeric Sulfonium and Selenium Compounds, Each Separately, in Water at 13°.

(Baker and Moffitt, 1930.)

| Isomer | Gms. per 100 cc sat. solution $C_8H_{10}O_2NS$ | Gms. per 100 cc sat. solution $C_8H_{10}O_2NSe$ |
|---|---|---|
| Para compounds | 0.161 | 0.076 |
| Meta " | 0.050 | 0.050 |
| Meta + Para compounds | 0.165 | 0.105 |

## BENZENE Sulfonic Acid Ethyl Ester, $C_6H_5SO_2.OC_2H_5$.

### Solubility in Water and in Several Aqueous Solutions at 25°.

(Karlsson, 1925.)

| Solvent. | Gms. mols. $C_6H_5SO_2.OC_2H_5$ per liter sat. sol. |
|---|---|
| Water | 0.00739 |
| 0.15 $n$ aq. NaOH | 0.00624 |
| 0.30 » | 0.00514 |
| 0.49 » | 0.00481 |
| 0.97 » | 0.00367 |
| 1.51 » | 0.00260 |
| 1.58 » | 0.00229 |
| 2.06 » | 0.00208 |
| 0.5 $n$ aq. NaCl | 0.00452 |
| 0.1 » | 0.00663 |
| 0.02 $n$ aq. Na acetate | 0.00702 |
| 0.05 » | 0,00664 |
| 0.02 » + 0.2 $n$ $CH_3COOH$ | 0.00712 |
| 0.0187 $n$ aq. $C_6H_5SO_3H$ | 0.00737 |
| 0.0378 $n$ » | 0.00733 |

## XYLENE m $C_6H_5(CH_3)_2$.

Freezing-point data for mixtures of m and p xylene and for mixtures of m xylene with benzene and with toluene are given by Nakatsuchi, 1926.

## DI METHYL ANILINE $C_6H_5N(CH_3)_2$.

### Reciprocal Solubility of Dimethyl Aniline and Glycerol.
(Parvatiker and McEwen, 1924.)

| $t^o$ | Gms. $C_6H_5N(CH_3)_2$ per 100 gms. sat. sol. | $t^o$ | Gms. $C_6H_5N(CH_3)_2$ per 100 gms. sat. sol. |
|---|---|---|---|
| 197.5 | 92.40 | 287.0 | 50.06 |
| 245.0 | 86.00 | 284.0 | 35.68 |
| 282.0 | 68.02 | 273.0 | 21.71 |
| 286.0 | 58.54 | 218.5 | 9.18 |

Freezing-point data for mixtures of Dimethyl aniline and:

| | |
|---|---|
| Acetic acid(3)(7) | Cresol(5) |
| Benzene(6) | Guaiacol(4) |
| Benzhydrol(6) | Phenol(1)(2) |
| Chloro phenol(1) | Tetramethyl diamino benzo phenone(6) |

(1) Bramley, 1916; (2) Kremann, 1906; (3) Puschin and Rikovski, 1932a; (4) Puschin and Rikovski, 1937; (5) Puschin and Sladovic, 1928; (6) Schmidlin and Lang, 1912; (7) O'Conner, 1924.

## ETHYL ANILINE $C_6H_5NH(C_2H_5)$.

### Critical Solution Temperatures of Ethyl Aniline and Other Solvents.
(Thiry, 1925.)

| Solvent | Crit. sol. temp. | Gms. $C_6H_5NHC_2H_5$ per 100 gms. mixture at c.s.t. |
|---|---|---|
| Hexane | -47.8 | 40.0 |
| Iso hexane | -40.8 | 40.0 |
| Tri methyl ethyl methane | -33.7 | 40.0 |

Freezing-point data are given by Yaginama and Hayakawa, 1932, for mixtures of Ethyl Aniline; di ethyl aniline and aniline.

## XYLIDINES $(CH_3)_2C_6H_3NH_2$, 1, 3, 4 and 1, 4, 3.

### Distribution of Xylidines at 25° Betwhen Water and Xylene.
(Smith, 1921, 1922.)

Results for the 1, 3, 4 Compound.

| Millimols. per liter | | $\frac{C_2}{C_1}$. |
|---|---|---|
| $H_2O$ layer ($C_1$). | Xylene layer ($C_2$). | |
| 0.1070 | 1.200 | 11.2 |
| 0.1385 | 1.525 | 11.0 |
| 0.2875 | 3.3125 | 11.5 |

Results for the 1, 4, 3 Compound.

| Millimols. per liter | | $\frac{C_2}{C_1}$. |
|---|---|---|
| $H_2O$ layer ($C_1$). | Xylene layer ($C_2$). | |
| 0.0740 | 1.100 | 14.9 |
| 0.1420 | 2.150 | 15.1 |
| 0.2875 | 4.462 | 15.5 |

100 gms. sat. solution of m Xylidine in water contain 0.66 gm. m $(CH_3)_2C_6H_3NH_2$ at 20°. (Lipetz and Rimskaja, 1931.)

Freezing-point data for mixtures of xylidines with cresols, phenol, ethyl phenol and xylenols are given by Morgan and Pettet, 1935. Results for mixtures of m xylidine and phenol are given by Kremann, 1906.

## BENZYL METHYL AMINE $C_6H_5CH_2.NHCH_3$.

DISTRIBUTION OF BENZYL METHYL AMINE AT 25° BETWEEN : (Smith, 1921-1922.)

| Water and Ethyl Ether. Millimols. $C_6H_5CH_2NHCH_3$ per liter of | | | Water and Xylene. Millimols. $C_6H_5CH_2NHCH_3$ per liter of | | |
|---|---|---|---|---|---|
| $H_2O$ layer ($C_1$). | $(C_2H_5)_2O$ layer ($C_2$). | $\frac{C_2}{C_1}$. | $H_2O$ layer ($C_1$). | $C_6H_4(CH_3)_2$ layer ($C_2$). | $\frac{C_2}{C_1}$. |
| 0.23 | 1.17 | 5.08 | 0.15 | 0.725 | 4.83 |
| 0.4 | 2.12 | 5.17 | 0.226 | 1.20 | 5.30 |
| 0.645 | 3.665 | 5.69 | 0.75 | 5.00 | 6.66 |
| 1.14 | 5.66 | 5.84 | 1.138 | 8.86 | 7.80 |
| 2.08 | 12.84 | 6.17 | | | |

## COLLIDINE (2.4.6 Trimethyl Pyridine) $C_5H_2N(CH_3)_3$.

SOLUBILITY IN WATER.
(Rothmund, 1898.)

| t°. | Gms. Collidine per 100 Gms. Aq. Layer. | Collidine Layer. | t°. | Gms. Collidine per 100 Gms. Aq. Layer. | Collidine Layer. |
|---|---|---|---|---|---|
| 5.7 crit. t. | 17.20 | | | | |
| 10 | 7.82 | 41.66 | 80 | 1.73 | 86.12 |
| 20 | 3.42 | 54.92 | 100 | 1.78 | 88.07 |
| 30 | 2.51 | 62.80 | 120 | 1.82 | 88.98 |
| 40 | 1.93 | 70.03 | 140 | 2.19 | 89.10 |
| 60 | 1.76 | 80.19 | 160 | 2.93 | 87.2 |
| | | | 180 | 3.67 | ... |

## COLLIDINE (1.3.5 Trimethyl Pyridine) $C_5H_2N(CH_3)_3$.

DISTRIBUTION BETWEEN WATER AND TOLUENE.
(Hantzsch and Vagt, 1901.)

| t°. | G. Mols. Collidine per Liter. $H_2O$ Layer. | Toluene Layer. | Dist. Coef. | t°. | G. Mols. Collidine per Liter. $H_2O$ Layer | Toluene Layer. | Dist. Coef. |
|---|---|---|---|---|---|---|---|
| 0 | 0.0035 | 0.0580 | 0.0603 | 50 | 0.0017 | 0.0596 | 0.0285 |
| 10 | 0.0026 | 0.0587 | 0.0443 | 70 | 0.0015 | 0.0597 | 0.0251 |
| 20 | 0.0022 | 0.0588 | 0.0374 | 90 | 0.0013 | 0.0598 | 0.0218 |
| 30 | 0.0020 | 0.0594 | 0.0337 | | | | |

**VERONAL** (Diethylbarbituric Acid) $CO<(NHCO)_2>C(C_2H_5)_2$. See also p. 203

100 cc. $H_2O$ dissolve 0.625 gm. veronal at 15–20°. (Squire & Caines, 1905.)
100 cc. 90% alcohol dissolve 11.7 gms. veronal at 15–20°. "
100 cc. ether dissolve 8.7 gms. veronal at 15–20°. "

100 cc. 86.5 % glycerol ($d = 1.2326$) dissolve 0.78 gm. veronal at 20°.
" 98.5 % " ($d = 1.2645$) " 0.96 " " " "
(Holm, 1921, 1922.)

$C_8H_{12}O_3$

SOLUBILITY OF VERONAL IN AQUEOUS SOLUTIONS OF PYRAMIDON.
(Irrera, 1931)

| Results at 14° | | Results at 19° | | Results at 27° | |
|---|---|---|---|---|---|
| Gms. per 100 cc sat. sol. | | Gms. per 100 cc sat. sol. | | Gms. per 100 cc sat. sol. | |
| Pyramidon | Veronal | Pyramidon | Veronal | Pyramidon | Veronal |
| 0.0 | 0.572 | 0.0 | 0.658 | 0.0 | 0.792 |
| 3.92 | 0.720 | 3.92 | 0.790 | 3.92 | 0.930 |
| 5.49 | 0.838 | 5.49 | 1.115 | 5.49 | 1.466 |

Freezing-point data are given for mixtures of Veronal (Barbital, Di ethyl barbituric acid) and:

Antipyrine(3)(5)
Acetyl amino antipyrine(3)
Benzanilide(3)
Bromural(7)
Pyramidon(2)(6)
Phenacetine(1)
Phenyl 2,3 dimethyl-5-pyrazolon(3)(5)
Salol(1)
Sarcosine anhydride(3)

Results for mixtures of Diallyl barbuturic acid + dimethyl amino antipyrine are given by (4)

(1) Hrynakowski and Szmyt. 1935d; (2) Pfeiffer, 1925; (3) Pfeiffer and Angern., 1926; (4) Pfeiffer and Ochiai, 1932; (5) Pfeiffer and Seydel, 1928; (6) Rheinboldt and Kirscheisen, 1925; (7) Sandquist and Hök. 1927.

Results for the freezing-points of mixtures of diallyl barbituric acids (methyl, ethyl, propyl, amyl and allyl) are given by Shonleand Kleiderer, 1934.

FUMARIC and MALEIC ACID DI ETHYL ESTERS $(:CHCOOC_2H_5)_2$.

Freezing-point data for mixtures of fumaric and maleic acid di ethyl esters are given by Wachholtz, 1927.

DIETHYL SUCCINIC ACID (Asym.) $HOOCCH_2C(C_2H_5)_2COOH$.

One liter sat. solution of asymetric di ethyl succinic acid in water contains 27.85 gm. $C_8H_{14}O_4$ at 25°.

DI ETHYL SUCCINATE $(CH_2)_2(COOC_2H_5)_2$.

100 cc $H_2O$ dissolve 1.92 gm $(CH_2)_2(COOC_2H_5)_2$ at 20°. (Sobotka and Kahn, 1931.)

Freezing-point data are given for mixtures of:

Diethyl succinate + Acetylene methyl tetra carbonate (Timmermans and
" " + Ethylene cyanide Mme. Vesselovsky. 1931.
" " + Ethyl Fumarate (Viseur, 1926.)
" " + Ethyl Maleate " "
" " + Tri chlor acetic acid (Kendall and Booge, 1916.)

AMYL MALONIC ACID n $(C_5H_{11})CH(COOH)_2$ at 25°.

100 gms. $H_2O$ dissolve 213.4 gms. $(C_5H_{11})CH(COOH)_2$ at 25°.
100 gms. $C_6H_6$ " 0.765 gms. " " "

(Verkade and Coops. 1930a.)

**SUBERIC ACID** $C_6H_{12}(COOH)_2$.

SOLUBILITY IN WATER.
(Lamouroux, 1899.)

| t°. | 0°. | 15°. | 20°. | 35°. | 50°. | 65°. |
|---|---|---|---|---|---|---|
| Gms. $C_6H_{12}(COOH)_2$ per 100 cc. sol. | 0.08 | 0.13 | 0.16 | 0.45 | 0.98 | 2.22 |

SOLUBILITY OF SUBERIC ACID IN ALCOHOLS AT 4°.
(Timofeiew, 1894.)

| Alcohol. | Gms. $C_6H_{12}(COOH)_2$ per 100 Gms. Sat. Sol. | Alcohol. |
|---|---|---|
| Methyl Alcohol | 20.32 | 32.04 |
| Ethyl Alcohol | 15.5 | 18.44 |
| Propyl Alcohol | 12.2 | 13.9 |

100 gms. 95 per cent formic acid dissolve 2.13 gms. $C_6H_{12}(COOH)_2$ at 19.5°.
(Aschan, 1913.)

Data for the distribution of suberic acid between water and ether at 25° are given by Chandler, 1908.

**SUBERIC ACID** $C_6H_{12}(COOH)_2$.

SOLUBILITY OF SUBERIC ACID IN AQUEOUS SOLUTIONS OF ACETIC ACID, HYDROCHLORIC ACID, NITRIC ACID AND SULFURIC ACID AT 25°.
(Knox and Richards, 1919.)

In aq. Acetic acid.

| Equiv. Normality. $CH_3COOH$. | $C_6H_{12}(COOH)_2$. |
|---|---|
| 0.0 | 0.0680 |
| 0.435 | 0.0776 |
| 0.887 | 0.0902 |
| 2.112 | 0.1340 |
| 4.262 | 0.2891 |
| 6.350 | 0.4317 |
| 8.402 | 0.5846 |

In aq. Hydrochloric acid.

| Equiv. Normality. HCl. | $C_6H_{12}(COOH)_2$. |
|---|---|
| 1.423 | 0.0498 |
| 2.858 | 0.0428 |
| 4.281 | 0.0412 |
| 5.691 | 0.0432 |
| 7.130 | 0.0504 |
| 8.378 | 0.0633 |
| 9.865 | 0.0905 |
| 11.20 | 0.1370 |

In aq. Sulfuric acid.

| Equiv. Normality. $H_2SO_4$. | $C_6H_{12}(COOH)_2$. |
|---|---|
| 0.000 | 0.068 |
| 1.858 | 0.039 |
| 5.233 | 0.037 |
| 7.524 | 0.042 |
| 11.33 | 0.060 |
| 18.65 | 0.200 |

| Equiv. Normality. $HNO_3$. | $C_6H_{12}(COOH)_2$. |
|---|---|
| 0.00 | 0.0680 |
| 0.307 | 0.0594 |
| 0.555 | 0.0590 |
| 0.906 | 0.0634 |

In aq. Nitric acid.

| Equiv. Normality. $HNO_3$. | $C_6H_{12}(COOH)_2$. |
|---|---|
| 1.543 | 0.0695 |
| 2.021 | 0.0839 |
| 4.035 | 0.0999 |
| 5.749 | 0.1133 |

| Equiv. Normality. $HNO_3$. | $C_6H_{12}(COOH)_2$. |
|---|---|
| 8.091 | 0.1575 |
| 10.05 | 0.2231 |
| 11.77 | 0.3896 |
| 13.30 | 0.6049 |

## DI ETHYL TARTRATE $(CHOH)_2(COOC_2H_5)_2$.

### Distribution of Diethyl Tartrate Between Water and Ethyl Ether.
(Tsuzuki, 1938.)

Results at 15°

| Gms. $C_8H_{14}O_6$ per 100 cc. $H_2O$ layer(1) | Gms. $C_8H_{14}O_6$ per 100 cc. $(C_2H_5)_2O$ layer(2) | 2/1 |
|---|---|---|
| 0.164 | 0.427 | 2.60 |
| 0.316 | 0.827 | 2.61 |
| 0.613 | 1.700 | 2.77 |

Results at 20°

| Gms. $C_8H_{14}O_6$ per 100 cc. $H_2O$ layer(1) | Gms. $C_8H_{14}O_6$ per 100 cc. $(C_2H_5)_2O$ layer(2) | 2/1 |
|---|---|---|
| 0.172 | 0.371 | 2.16 |
| 0.446 | 1.01 | 2.26 |
| 0.910 | 2.11 | 2.31 |
| 2.28 | 5.19 | 2.28 |

### Distribution of Diethyl Tartrate Between Ether and Aqueous Borate Solutions.
(Tsuzuki, 1938.)

Results at 15°

| Gm. Mols. Borate per liter aq. layer | Gms. $C_8H_{14}O_6$ per 100cc. Aq. layer(1) | $(C_2H_5)_2O$ layer(2) | 2/1 |
|---|---|---|---|
| 0.25 $KBO_2$ | 0.021 | 0.93 | 44 |
| " " | 0.051 | 1.77 | 34 |
| " " | 0.136 | 3.43 | 25 |
| " " | 0.170 | 3.92 | 23 |
| 0.25 $H_3BO_3$ | 0.305 | 0.826 | 2.71 |
| " " | 0.618 | 1.595 | 2.58 |
| " " | 0.921 | 2.452 | 2.66 |
| " " | 1.212 | 3.380 | 2.79 |

Results at 20°

| Gm. Mols. Borate per liter aq. layer | Gms. $C_8H_{14}O_6$ per 100cc. Aq. layer(1) | $(C_2H_5)_2O$ layer(2) | 2/1 |
|---|---|---|---|
| 0.25 $KBO_2$ | 0.026 | 0.83 | 32.0 |
| " " | 0.063 | 1.55 | 24.7 |
| " " | 0.206 | 3.43 | 16.7 |
| " " | 0.577 | 5.48 | 9.5 |
| " " | 0.876 | 6.40 | 7.3 |
| 0.05 $Na_2B_4O_7$ | 0.109 | 1.271 | 11.7 |
| " " | 0.298 | 2.355 | 7.88 |
| " " " | 0.834 | 4.159 | 4.98 |

## ETHYL CYCLOHEXANE $C_2H_5C_6H_{11}$.

The critical solution temperature of mixtures of Ethyl Cyclohexane and Sulfur dioxide is 25° and the reciprocal solubility curve at this temperature is practically flat between the concentrations 55 to 88 mol. percent $SO_2$.
(Leslie, 1934.)

## CAPRYLIC ACID $CH_3(CH_2)_6COOH$.

5.0cc aq. 2.0 normal sodium benzoate solution dissolve 0.22 cc caprylic acid at about 18°. (Traube, Schöning and Weber, 1927.)

### Distribution of Caprylic Acid at About 18 Between Water and Petroleum Ether.
(Grossfeld and Miermeister, 1931.)

| cc 0.002 n NaOH required per 25 cc $H_2O$ layer(1) | Pet. Ether layer(2) | 1/2 |
|---|---|---|
| 1.5 | 12.0 | 0.125 |
| 1.8 | 17.2 | 0.104 |
| 2.3 | 29.7 | 0.077 |
| 2.9 | 43.1 | 0.067 |
| 3.4 | 67.5 | 0.050 |

### Distribution of Caprylic Acid Between 2,2,4 Trimethyl Pentane and β Methoxy Ethanol.

(Henriques, 1933.)

Results at -19.5°

| Gm. Mols. $C_8H_{16}O_2$ per liter | | $\frac{1}{2}$ |
|---|---|---|
| Pentane layer(1) | Ethanol layer(2) | |
| 0.0039 | 0.0522 | 0.075 |
| 0.0122 | 0.1447 | 0.084 |
| 0.0200 | 0.2344 | 0.085 |

Results at 0°

| Gm. Mols. $C_8H_{16}O_2$ per liter | | $\frac{1}{2}$ |
|---|---|---|
| Pentane layer(1) | Ethanol layer(2) | |
| 0.0058 | 0.0482 | 0.12 |
| 0.0177 | 0.1328 | 0.13 |
| 0.0291 | 0.2159 | 0.14 |

### Distribution of Caprylic Acid Between 2,2,4-Trimethyl Pentane and Methanol at 0°.

(Smith and Norton, 1932.)

| Gm. Mol. $C_8H_{16}O_2$ per liter | | $\frac{1}{2}$ |
|---|---|---|
| Pentane layer(1) | Methanol layer(2) | |
| 0.00686 | 0.03801 | 0.180 |
| 0.02120 | 0.10575 | 0.201 |

Results showing the distribution of caprylic acid between water and olive oil at 23° are given by Bodansky, 1928.

**ETHYL CAPROATE** $CH_3(CH_2)_4COOC_2H_5$.

100cc $H_2O$ dissolve 0.063 gm. $C_8H_{16}O_2$ at 20°. (Sobotka and Kahn, 1931.)

**TRI CAPRYLIN** $C_3H_5[CH_3(CH_2)_6COOH]_3$.

Results for the reciprocal solubility of tri caprylin and benzene are given by Loskit, 1928.

**AMYL PROPIONATE** $C_2H_5COOC_5H_{11}$.

100 cc $H_2O$ dissolve 0.1 cc Amyl propionate at 20°. (Bancroft, 1895; Traube, 1884.)

"Octane Sultone" $C_8H_{16}O_3S$.

### Solubility in Several Organic Solvents at 20°.

(Baldschwieler and Cassar, 1929.)

| Solvent | Gms. $C_8H_{16}O_3S$ per 100 gms. sat. sol. | Solvent | Gms. $C_8H_{16}O_3S$ per 100 gms. sat. sol. |
|---|---|---|---|
| Ethyl Ether | 4.84 | Ethyl Alcohol | 4.98 |
| Benzene(90%) | 25.88 | " " (95%) | 5.21 |
| Chloroform | 55.57 | Iso propyl alcohol | 4.37 |
| Acetone | 52.43 | Benzine (normal) | 0.22 |
| Methyl alcohol | 13.15 | | |

**CONIINE** (α Propyl Piperidine) $C_5H_{10}N.C_3H_7$

100 gms. $H_2O$ dissolve 1.83 gms. coniine at 20°. (Zalai, 1910.)

DISTRIBUTION OF CONIINE AT 25° BETWEEN : (Smith, 1921-1922.)

| Water and Ether. Millimols. per liter of $H_2O$ layer ($C_1$). | Millimols. per liter of $(C_2H_5)_2O$ layer ($C_2$). | $\frac{C_2}{C_1}$. | Water and Xylene. Millimols. per liter of $H_2O$ layer ($C_1$). | Millimols. per liter of $C_6H_4(CH_3)_2$ layer ($C_2$), | $\frac{C_2}{C_1}$. |
|---|---|---|---|---|---|
| 0.19 | 1.055 | 5.55 | 0.146 | 0.861 | 5.9 |
| 0.33 | 1.875 | 5.68 | 0.265 | 1 735 | 6.5 |
| 0.62 | 3.72 | 7.16 | 0.495 | 3.505 | 7.1 |
| 1.06 | 7.38 | 6.95 | 0.935 | 9.065 | 9.8 |

**OCTANE** $CH_3(CH_2)_6CH_3$.

100 cc. $H_2O$ dissolve approx. 0.002 cc. octane at 16° (Fühner, 1924.)

MUTUAL SOLUBILITY OF NORMAL OCTANE AND SULFUR DIOXIDE.
(Seyer and Gallaugher, 1926.)

| t°..... | —19.7. | —18.6. | +0.7. | 19.81. | 26.85. | 24.25. | —3.6. | —10.8. |
|---|---|---|---|---|---|---|---|---|
| Wt. % $C_8H_{18}$..... | 96.34 | 87.44 | 76.95 | 61.37 | 50.0 | 17.26 | 3.39 | 2.42 |

The critical solution temperature of mixtures of octane and sulfur dioxide is 25.5° and the reciprocal solubility curve at this temperature is practically flat between the concentrations 50 and 90 mol. % $SO_2$. (Leslie, 1934.)

**OCTANE** $CH_3(CH_2)_6CH_3$.

RECIPROCAL SOLUBILITY OF OCTANE AND PHENOL.
(Campetti and Del Grosso, 1913.)

| t°. | Gms. Phenol per 100 Gms. Mixture. | t°. | Gms. Phenol per 100 Gms. Mixture. |
|---|---|---|---|
| 22.55 | 13.28 | 49.5 crit. t. | 52.2 |
| 37.85 | 22.74 | 49.35 | 52.37 |
| 38.15 | 23.53 | 44.7 | 71.14 |
| 44.70 | 32.85 | 30.65 | 82.01 |
| 47.75 | 41.72 | 19.65 | 85.99 |

Freezing-point data are given for mixtures of:

Octane and Dotriacontane (Diacetyl). $CH_3(CH_2)_{30}CH_3$, (Seyer, 1938.)
Octane and Nonane (Smittenberg. Hoog and Henks, 1938.)

**TETRA METHYL BUTANE** 2,2,3.3,- $CH_3C(CH_3)_2C(CH_3)_2CH_3$.

Freezing-point data for mixtures of tetra methyl butane and tri methyl butane are given by Smittenberg, Hoog and Henkes, 1938.

**TRI METHYL PENTANE** 2,2,4- $CH_3C(CH_3)_2CHCH_3CH_2CH_3$.

Freezing-point data for mixtures of tri methyl pentane and heptane are given by Smittenberg, Hoog and Henkes, 1938.

**2-METHYL HEPTANE** $(CH_3)_2CH(CH_2)_4CH_3$.

The critical solution temperature of mixtures of 2-Methyl Heptane and Sulfur dioxide is 24° and the reciprocal solubility curve at this temperature is practically flat between the concentrations 50 and 90 Mol. % $SO_2$. (Leslie, 1934.)

**OCTYL ALCOHOL** (normal) $CH_3(CH_2)_6CH_2OH$.

100 gms. sat. aqueous solution of normal octyl alcohol contain 0.0586 gm. $C_8H_{18}O$ at 25°. (Butler, Thomson and Maclennon, 1933.)

5.0 cc of aqueous saturated sodium benzoate solution dissolve 1.1 cc octyl alcohol at about 18°. (Traube, Schöning and Weber, 1927.)

**OCTYL ALCOHOL** (Secondary) $CH_3(CH_2)_5CHOH.CH_3$.

By means of a new optical method, involving the use of an interferometer of the type described by Janin (*Ann. chim. phys.*, 52, 171, 1858), it was found that 1000 cc. of $H_2O$ dissolve 1.508 gms. sec. octyl alcohol at 15° and 1.280 gms. at 25° (Mitchell, 1926.)

**2,2,3-TRI METHYL PENTANOL-3** $(CH_3)_3C.COH(CH_3)CH_2CH_3$.

RECIPROCAL SOLUBILITY OF TRIMETHYL PENTANOL AND WATER.
(Ginnings and Coltrane, 1939.)

| d. and B. pt. of the pure Tri methyl Pentanol | | t° | Gms. $C_8H_{18}O$ per 100 gms. sat. sol. in $H_2O$ | Gms. $H_2O$ per 100 gms. sat. sol. in $C_8H_{18}O$ |
|---|---|---|---|---|
| 0.8420 | 153°-154° | 20 | 0.75(0.9975) | 1.98(0.8536) |
| " | " | 25 | 0.69(0.9964) | 2.01(0.8503) |
| " | " | 30 | 0.64(0.9951) | 2.02(0.8455) |

The figures in parentheses are densities of the sat. solutions.

**DI n BUTYL ETHER** $(C_4H_9)_2O$.

The solubility of Di-n-Butyl Ether in water is less than 0.01 gm. per 100 gms. sat. solution at 17°. (Bennett and Philip, 1928.)

**TRIONAL** $C_2H_5(CH_3)C(SO_2.C_2H_5)_2$. ( See also p. 568

10 cc. of horse serum dissolve 0.0102 gm. trional at 20°. The distribution between horse serum in contact with olive oil was found to be 0.0080 gm. trional per 10 cc. of serum layer and 0.0022 gm. per 10 cc. of olive oil layer at 20°. (Aiello, 1921.)

**TETRA ETHYL AMMONIUM PHOSPHOR HEXA FLUORIDE** $(C_2H_5)_4N.PF_6$.

One liter sat. solution of Tetra ethyl ammonium phosphur hexa fluoride in water contain 8.1 gm. $(C_2H_5)_4N.PF_6$ at 19°. ( Lang and Muller 1930.)

**Phenyl PROPIOLIC ACID** $C_6H_5C : C.COOH$.

SOLUBILITY IN SEVERAL SOLVENTS. (Herz and Rathmann, 1913.)

| Solvent. | $C_6H_5C:C.COOH$ per Liter. Mols. | Gms. | Solvent. | $C_6H_5C:C.COOH$ per Liter. Mols. | Gms. |
|---|---|---|---|---|---|
| Chloroform | 0.789 | 115.30 | Tetrachloro Ethylene | 0.324 | 47.34 |
| Carbon Tetrachloride | 0.227 | 33.16 | Tetrachloro Ethane | 0.718 | 104.90 |
| Trichloro Ethylene | 0.382 | 55.82 | Pentachloro Ethane | 0.410 | 59.91 |

**COUMARIN** (1,2 Benzo pyrone) $C_6H_4OCOCH:CH$.

100 gms. water dissolve 0.01 gm. coumarin at 20°–25°. (Dehn, 1917.)
" pyridine " 87.7 gms. " " " "
" 50% aq. pyridine " 60.1 " " " "
" chloroform " 49.4 " " " 25°. (Osaka, 1903–08.)

100 gms. abs. alcohol dissolve 12.57 gms. Coumarin at 20-25°.
» quinoline » 0.56 » » » } (Pucher and Dehn, 1921.)
» equi mol. mixture of alcohol and quinoline dissolve 0.8 gm. Coumarin at 20–25°.

Solubility of Coumarin in Aqueous Solutions of Glycerol.
(de Groote, 1920.)

Note. — The glycerol solutions were prepared by diluting given volumes of C. P. grade 95% glycerol with water in a 1000 cc. flask. Thus the 5% glycerol was prepared by diluting 50 cc. of 95 % glycerol (measured at 20°) to 1000 cc. with water at 20°. The saturated solutions were prepared by adding an excess of coumarin to 500 cc. of solvent at a temperature about 10° higher than that of the determination, and then allowing to stand at the selected temperature, with intermittent shaking, for 72 hours. The saturated solutions were analyzed by extracting the coumarin with ether. The ethereal extract was evaporated and the residue dissolved in water and again extracted with ether. The residue of purified coumarin was dried at 30° and weighed. The curves given by the results are not as smooth as is desirable.

| Per cent of 95 % glycerol in solvent. | Gms. Coumarin per 100 cc. sat. solution at | | | | | |
|---|---|---|---|---|---|---|
| | 0°.2. | 20°. | 30°. | 40°. | 50°. | 60°. |
| 0.0 (= $H_2O$).... | 0.09 | 0.19 | 0.26 | 0.45 | 0.65 | 0.70 |
| 5.0..... | 0.10 | 0.20 | 0.28 | 0.47 | 0.68 | 0.80 |
| 10.0..... | 0 12 | 0.22 | 0.31 | 0.50 | 0.72 | 0.88 |
| 15.0..... | 0.13 | 0.24 | 0.36 | 0.55 | 0.78 | 0.98 |
| 20.0..... | 0.14 | 0.26 | 0.38 | 0.56 | 0.85 | 1.09 |
| 25.0..... | 0.14 | 0.28 | 0.43 | 0.60 | 0.92 | 1.17 |
| 30.0..... | 0.15 | 0.30 | 0.47 | 0.65 | 1 03 | 1.30 |
| 40.0..... | 0.19 | 0.37 | 0.55 | 0.77 | 1.16 | 1.75 |
| 50.0..... | 0.28 | 0.50 | 0.68 | 0.92 | 1.46 | 2.20 |

Freezing-point data are given for mixtures of:

Coumarin + Phosphorus acid (Redfield and King, 1936.)
" + Sulfuric acid (Kendall and Carpenter, 1914.)
" + p Toluidine (Puschin and Zivadinovic, 1933.)
" + s Trinitro benzene (Sudborough and Beard, 1911.)

**PHTHALONIC ACID** (o) $HOOC.C_6H_4.CO.COOH.2H_2O$.

100 gms. $H_2O$ dissolve 115.0 gms. Phthalonic acid at 15° (Sidgwick and Clayton, 1922.)
» $CHCl_3$ » 2.0 » » » »

100 gms. sat. solution in water contain 64.4 gms. anhydrous acid at 15°, Sp. Gr. of sat. solution = 1.243. (Tcherniac, 1916.)

Amide of **PHTHALIDECARBOXYLIC ACID** $C_6H_4<\begin{matrix}CH(CONH_2)\\CO\end{matrix}>O$ (m. pt. 185.5°).

100 gms. $H_2O$ dissolve 0.132 gm. of the acid at 16.2° and 5.7 gms. at b. pt. (Tcherniac, 1916.)

## QUINOLINE $C_9H_7N$.

DISTRIBUTION OF QUINOLINE AT 25° BETWEEN WATER AND XYLENE.
(Smith, 1921, 1922.)

| Millimols. $C_9H_7N$ per liter of | | $\frac{C_2}{C_1}$. |
|---|---|---|
| $H_2O$ layer ($C_1$). | Xylene layer ($C_2$). | |
| 0.116 | 1.80 | 15.5 |
| 0.250 | 4.20 | 16.8 |
| 0.470 | 9.40. | 20.0 |

Freezing-point data are given for mixtures of Quinoline and:

Acetic acid(3)
Benzoic acid(1)
Cresols(5)
Guaiacol(4)
Nitroso dimethyl aniline(6)
Phenol(2)
o Chloro phenol(2)

(1) Baskov, 1918; (2) Bramley, 1916; (3) Puschin and Rikovski, 1932a; (4) Puschin and Rikovski, 1937; (5) Puschin and Sladovic, 1928; (6) Kremann and Wlk, 1919.

## QUINOLINE HELIANTHATE $C_{14}H_{15}N_3SO_3.C_9H_7N$.

1000 cc. $H_2O$ dissolve 0.854 gms. quinoline helianthate at 20-25°. (Stark and Dehn, 1918.)

## α BROMO CINNAMIC ALDEHYDE $BrC_6H_4CH:CHCHO$.

Freezing-point data for mixtures of α Bromo cinnamic aldehyde and α Chloro cinnamic aldehyde are given by Küster, 1891.

## BromoCINNAMIC ACIDS.

SOLUBILITY OF α AND OF β BROMOCINNAMIC ACIDS IN WATER AT 25°.
(Paul, 1894.)

| Acid. | Per 1000 cc. Sat. Solution. | |
|---|---|---|
| | Gms. | Millimols. |
| α $C_6H_5CH:CBrCOOH$ | 3.9325 | 17.32 |
| β $C_6H_5CBr:CHCOOH$ | 0.5255 | 2.315 |

SOLUBILITY OF α ISO BROMOCINNAMIC ACID IN AQUEOUS SOLUTIONS OF OXANILIC ACID (Melting point = 120°) AT 25°.
(Noyes, 1890.)

| Normality of Solutions. | | Grams per Liter. | |
|---|---|---|---|
| $C_6H_5NHCO$-COOH. | $C_6H_5CH$-CBrCOOH. | $C_6H_5NHCO$-COOH. | $C_6H_5CH$-CBrCOOH. |
| 0 | 0.0176 | 0 | 3.995 |
| 0.0275 | 0.0140 | 4.54 | 3.178 |
| 0.0524 | 0.0129 | 8.65 | 2.928 |

SOLUBILITY OF α CHLOROCINNAMIC ACID, ETC., IN BENZENE.
(Stoermer and Heymann, 1913.)

| Name of Compound. | M. pt. | t°. | Gms. Cmpd. per 100 Gms. $C_6H_6$. |
|---|---|---|---|
| α Chlor- cinnamic Acid | 137 | 20 | 2.6 |
| Allo α " " | 111 | 21 | 11 |
| α Brom- " | 131 | 20 | 5.17 |
| Allo α " " | 120 | 18.5 | 6.9 |
| β Chlor- " | 142 | 17 | 1.94 |
| Allo β " " | 132 | 16 | 3.17 |
| β Brom- cinnamic Acid | 135 | 13 | 1.58 |
| Allo β " " | 159.5 | 14 | 0.86 |
| *cis* Dichlor- " | 121 | 13 | 6.1 |
| *trans* " " | 101 | 14 | 21.2 |
| *cis* Dibrom- " | 100 | 14 | 26.9 |
| *trans* " " | 136 | 14 | 10.6 |

## CINNAMIC ALDEHYDE $C_6H_5.CH:CH.CHO$.

Freezing-point lowering data for mixtures of cinnamic aldehyde and each of the following compounds are given by Kremann and Zechner, 1925.

| | |
|---|---|
| α and β Naphtol | Pyrocatechol |
| *o*, *m*, *p* Nitro phenol | Resorcinol |

## Allo CINNAMIC ACIDS (Unstable Isomers of Cinnamic Acid).

SOLUBILITY OF EACH OF THE THREE ISOMERIC ALLOCINNAMIC ACIDS AND OF THE MELTS OF THE THREE ISOMERS IN WATER.
(Meyer, 1911.)

Results for:

| Allocinnamic Acid of M. pt. 68°. | | Allocinnamic Acid of M. pt. 58°. (Natural Isocinnamic Acid.) | | Allocinnamic Acid of M. pt. 42°. (Artificial Isocinnamic Acid.) | | Melted Allocinnamic Acid. | |
|---|---|---|---|---|---|---|---|
| t°. | Gms. Acid per Liter. | t°. | Gms. Acid per Liter. | t°. | Gms. Acid per Liter. | t°. | Gms. Acid per Liter |
| 18 | 6.88 | 18 | 7.62 | 18 | 8.95 | 18 | 13.63 |
| 25 | 8.45 | 25 | 9.37 | 25 | 11.03 | 25 | 14.44 |
| 35 | 11.14 | 35 | 12.39 | 35 | 14.61 | 35 | 16.05 |
| 45 | 14.46 | 45 | 16.09 | | | 45 | 18.11 |
| 55 | 18.45 | | | | | 55 | 20.55 |
| | | | | | | 65 | 23.43 |
| | | | | | | 75 | 27.69 |

These curves intersect that for the melted acid at the melting points of the solid isomers.

The results show that the three isomers are polymorphic modifications of the *cis* acid.

100 gms. ligroïn (b. pt. 60–70°) dissolve more than 16 gms. isocinnamic acid.
(Liebermann, 1903.)

100 gms. ligroïn (b. pt. 60–70°) dissolve approx. 2 gms. allocinnamic acid. "

## CINNAMIC ACID $C_6H_5CH:CH.COOH$.

SOLUBILITY OF CINNAMIC ACID IN WATER.

| t° | Gms. $C_6H_5CH:CHCOOH$ per 100 gms. $H_2O$ | Authority |
|---|---|---|
| 25 | 0.0495 | De Jong, 1909. |
| 25 | 0.0546 | Meyer, 1911. |
| 25 | 0.0607 | Sidgwick, 1910. |
| 25 | 0.0604 | Gross, Saylor and Gorman, 1933. |

100 cc. 0.5 n sodium cinnamate solution dissolve 0.155 gm. $C_6H_5CH:CHCOOH$ at 25°. (Sidgwick, 1910.)

## Solubility of Cinnamic Acid in Water at Temperatures Above 100°.

(Kume, 1937.)

| t° | Gms. $C_9H_8O_2$ per 100 gms. sat. sol. | t° | Gms. $C_9H_8O_2$ per 100 gms. sat. sol. | t° | Gms. $C_9H_8O_2$ per 100 gms. sat. sol. |
|---|---|---|---|---|---|
| 131 | 17.50(3) | 137 | 66.99 | 116.7 | 94.99(2) |
| 139 | 35.6(3) | 115 | 80.12 | 119.0 | 95.01(2) |
| 140.5(Cr.T. | 49.0 | 107.1 | 80.12(1) | 125.0 | 97.61(2) |
| 107.2 | 50.17(1) | 114.7 | 80.12(1) | 129.0 | 98.90(2) |
| 139.5 | 50.17 | 110 | 89.69(2) | 130.5 | 99.29(2) |
| 140 | 53.18 | 110.5 | 92.23(2) | | |

(1) Solid + 2 liquids; (2) Solid + one liquid; (3) Two liquid layers.

## Solubility of Cinnamic Acid in Aqueous Solutions of Hydrochloric Acid at 25°. (Knox and Richards, 1919.)

| Equivalent normality | | Equivalent normality | |
|---|---|---|---|
| HCl. | $C_9H_8O_2$. | HCl. | $C_9H_8O_2$. |
| 0.00 | 0.00385 | 8.007 | 0.00400 |
| 2.100 | 0.00283 | 10.29 | 0.00556 |
| 4.174 | 0.00272 | 10.47 | 0.00572 |
| 6.250 | 0.00318 | | |

## Solubility of Cinnamic Acid in Aqueous Solutions of Sodium Salts at 25°.

(Larsson, 1926, 1927.)

| Solvent | Gm. mols. $C_9H_8O_2$ per liter |
|---|---|
| Water alone | 0.00334 (= 0.4945 gm.) |
| Aq. 0.025 normal Na acetate | 0.0127 |
| " 0.05 " " " | 0.0176 |
| " 0.10 " " " | 0.0242 |
| " 0.025 " " fumarate | 0.00938 |
| " 0.05 " " " | 0.0126 |

## Solubility of Cinnamic Acid in Aqueous Solutions of Sodium Salts.

(Doosaj and Bhagwat, 1933; Bhagwat and Doosaj, 1933.)

In aqueous solutions of:

Sodium acetate at 30°

| Gms. per liter | |
|---|---|
| $CH_3COONa$ | $C_9H_8O_2$ |
| 2.3574 | 1.763 |
| 3.5322 | 2.334 |
| 7.0643 | 2.907 |
| 10.4281 | 3.525 |
| 19.9087 | 4.825 |
| 36.4989 | 6.563 |
| 43.7986 | 7.224 |
| 72.9977 | 9.162 |
| 109.4966 | 11.10 |
| 218.9932 | 18.41 |

Sodium citrate at 30°

| Gms. per liter | |
|---|---|
| $(CH_2)_2C(OH)(COONa)_3$ | $C_9H_8O$ |
| 0.0 | 0.6937 |
| 5.3701 | 3.469 |
| 7.9274 | 4.317 |
| 15.1341 | 6.322 |
| 27.7459 | 8.486 |
| 33.2951 | 9.404 |
| 55.4918 | 11.75 |
| 83.2377 | 12.79 |
| 110.9836 | 13.69 |
| 166.4754 | 14.49 |

Sodium benzoate at 16.3°

| Gms. per liter | |
|---|---|
| $C_6H_5COONa$ | $C_9H_8O_2$ |
| 0.0 | 0.3914 |
| 1.7306 | 0.7827 |
| 3.4612 | 1.021 |
| 6.9224 | 1.393 |
| 17.3061 | 2.069 |
| 34.6121 | 2.997 |
| 57.6868 | 4.212 |
| 86.5303 | 5.121 |
| 115.3737 | 5.571 |

### Solubility of Cinnamic Acid in Aqueous Solutions of Sodium Acetate, Butyrate, Formate, and Salicylate at 26.4°.

(Philip — J Chem. Soc. 87, 992, '05.)

Calculated from the original results, which are given in terms of molecular quantities per liter.

| Gms Na Salt per Liter. | Gms. $C_6H_5CH:CH.COOH$ per Liter in Solutions of: | | | |
|---|---|---|---|---|
| | $CH_3COONa$. | $C_3H_7COONa$. | HCOONa. | $C_6H_4.OH.COONa$. |
| 0 | 0.56 | 0.56 | 0.56 | 0.56 |
| 1 | 1.50 | 1.30 | 0.92 | 0.62 |
| 2 | 2.12 | 1.85 | 1.12 | 0.70 |
| 3 | 2.52 | 2.25 | 1.27 | 0.73 |
| 4 | 2.85 | 2.60 | 1.40 | 0.77 |
| 5 | 3.05 | 2.90 | 1.47 | 0.80 |
| 8 | ... | ... | ... | 0.90 |

1 liter of aqueous solution contains 0.491 gm. $C_6H_5CH:CH.COOH$ at 25° (Paul).

### Solubility of Cinnamic Acid in Aqueous Solutions of Anilin and of Para Toluidin at 25°.

(Lowenherz — Z. physik. Chem. 25, 394, '98.)

Original results in terms of molecular quantities per liter.

In Aqueous Anilin.

| Grams per Liter. | |
|---|---|
| $C_6H_5NH_2$. | $C_6H_5CH:CHCOOH$. |
| 0 | 0.49 |
| 1 | 1.20 |
| 2 | 1.65 |
| 3 | 2.02 |
| 4 | 2.35 |
| 6 | 2.92 |

In Aqueous *p* Toluidin.

| Grams per Liter. | |
|---|---|
| $C_6H_4CH_3NH_2$. | $C_6H_5CH:CHCOOH$. |
| 0 | 0.49 |
| 1 | 1.52 |
| 2 | 2.20 |
| 3 | 2.83 |
| 4 | 3.35 |
| 5 | 3.80 |

### Distribution of Cinnamic Acid at 25° Between:

(Smith and White, 1929.)

Water and Chloroform

| Gm. Mols. $C_9H_8O_2$ per liter | |
|---|---|
| $H_2O$ layer | $CHCl_3$ layer |
| 0.00077 | 0.0684 |
| 0.0084 | 0.0788 |
| 0.00098 | 0.0921 |
| 0.00112 | 0.1195 |
| 0.00132 | 0.1364 |

Water and Toluene

| Gm. Mols. $C_9H_8O_2$ per liter | |
|---|---|
| $H_2O$ layer | $C_6H_5CH_3$ layer |
| 0.00126 | 0.0506 |
| 0.00175 | 0.0790 |
| 0.00227 | 0.1050 |
| 0.00244 | 0.1215 |
| 0.00264 | 0.1397 |

### Distribution of Cinnamic Acid Between Water and Xylene at 25°.

(Smith, 1921-1922.)

| Millimols. $C_9H_8O_2$ per liter of | | |
|---|---|---|
| $H_2O$ layer ($C_1$). | $C_6H_4(CH_3)_2$ layer ($C_2$). | $\frac{C_2}{C_1}$. |
| 0.160 | 0.465 | 2.90 |
| 0.225 | 1.025 | 4.55 |
| 0.295 | 2.215 | 7.45 |

100 cc. sat. sol. in petroleum ether (b. pt. 30°–70°) contain 0.095 gm. $C_6H_5CH:CH.COOH$ at 26°.

100 cc. sat. sol. in carbon tetrachloride contain 2.172 gms. $C_6H_5CH:CH.COOH$ at 26°.

(De Jong, 1909.)

100 cc. sat. sol. in 95% formic acid contain 3.76 gms. $C_6H_5CH:CH.COOH$ at 20°.

(Aschan, 1913.)

SOLUBILITY OF CINNAMIC ACID (Melting point, 133°) IN ALCOHOLS. (Timofeiew, 1894.)

| t°. | Gms. Cinnamic Acid per 100 Gms. Sat. Solution in: $CH_3OH$. | $C_2H_5OH$. | $C_3H_7OH$. | $(CH_3)_2CH.CH_2OH$. |
|---|---|---|---|---|
| −18 | 8.1 | 6.74 | 4.3 | ... |
| −12.5 | 9.3 | 8 | 5.5 | ... |
| 0 | 13 | 11.3 | 8.2 | ... |
| +19.5 | 22.5 | 18.1 | 13.4 | 8.6 |

SOLUBILITY OF CINNAMIC ACID IN ORGANIC SOLVENTS AT 25°. (Herz and Rathmann, 1913.)

| Solvent. | Gms. $C_6H_5CH$: CHCOOH per 100 cc. Sat. Sol. | Solvent. $CHCl_3$ | | $CCl_4$ | Gms. $C_6H_5CH$: CHCOOH per 100 cc. Sat. Sol. | Solvent. $C_2HCl_3$ | | $C_2HCl_5$ | Gms. $C_6H_5$ CH:CH-COOH per 100 cc. Sat. Sol. |
|---|---|---|---|---|---|---|---|---|---|
| Chloroform | 12.09 | 100 | cc.+ 0 | cc. | 12.09 | 100 | cc.+ 0 | cc. | 6.04 |
| Carbontetrachloride | 1.75 | 80 | " + 20 | " | 9.86 | 80 | " + 20 | " | 5.91 |
| Trichlorethylene | 6.04 | 50 | " + 50 | " | 6.61 | 50 | " + 50 | " | 5.85 |
| Tetrachlorethylene | 2.55 | 33.3 | " + 66.6 | " | 4.50 | 33.3 | " + 66.6 | " | 5.82 |
| Tetrachlorethane | 11.05 | 20 | " + 80 | " | 3.32 | 20 | " + 80 | " | 5.70 |
| Pentachlorethane | 5.54 | 0 | " +100 | " | 1.75 | 0 | " +100 | " | 5.54 |

SOLUBILITY OF CINNAMIC ACID IN SEVERAL SOLVENTS.

| Solvent. | t°. | Gms. $C_9H_8O_2$ per 100 gms. solvent. | Authority. |
|---|---|---|---|
| Absolute ethyl alcohol | 20–25 | 22.03 | (Pucher and Dehn, 1921. |
| Quinoline | » | 1.85 | » |
| Equi mol. mixture of alcohol and quinoline | » | 132.40 | » |
| Dichlor acetylene (cis) (b. pt. 60°.2) | 0 | 2.32 | (Lebrun. 1925.) |
| » » (trans.) (b. pt 48°.3) | 0 | 1.93 | » |
| Bromobutene (b. pt. 93°.9) | 40 | 4.65 | » |
| » (b. pt. 85°.5-85°.6) | 40 | 3.68 | » |
| Crotonic nitrile (b. pt. 107°.7–108°.2) | 30 | 10.27 | » |
| » » (b pt. 121°.8–122°.2) | 30 | 9.72 | » |
| Ethyl chlor isocrotonate | 20 | 4 38 | » |
| Cocoanut oil | 25 | 1.77 | (Verkade, 1921.) |
| Cotton seed oil | 25 | 1.44 | » |
| Castor oil | 25 | 7.52 | » |
| Linseed oil | 25 | 1.66 | » |
| Olive oil | 25 | 1.29 | » |
| Peanut oil I | 25 | 1.62 | » |
| » II | 25 | 1.42 | » |

SOLUBILITY OF CINNAMIC ACID IN WATER AND IN OTHER SOLVENTS.
(Desai and Patel, 1935.)

| Solvent | Gm. Mol. $C_9H_8O_2$ per 1.0 gm. mols. sat. sol. | Solvent | Gm. Mols. $C_9H_8O_2$ per 1.0 gm. mols. sat. sol. |
|---|---|---|---|
| Water | 0.00894 | Chloroform | 7.268 |
| $CCl_4$ | 1.071 | Methyl alcohol | 6.337 |
| Benzene | 3.033 | Ethyl alcohol | 7.665 |
| Toluene | 2.966 | n Propyl alcohol | 8.500 |
| m Xylene | 2.852 | n Butyl alcohol | 9.156 |
| Chloro benzene | 3.608 | Acetone | 11.930 |
| Nitro benzene | 4.965 | | |

SOLUBILITY OF CINNAMIC ACID IN SEVERAL STERIOISOMERIC SOLVENTS.
(Lebrun, 1930.)

| Solvent | b. pt. of solvent | t° | Gms. $C_9H_8O_2$ per 100 gms. solvent |
|---|---|---|---|
| Acetylene dichloride (Cis) | 60.2 | 0 | 2.32 |
| " " (Trans.) | 48.3 | 0 | 1.93 |
| β Chlor iso crotonate (Cis) | — | 20 | 4.38 |
| Bromo butene (Cis) | 94.9 | 40 | 4.65 |
| " " (Trans) | 85.5 | 40 | 3.68 |
| Crotonic nitrile | 107-7-108.2 | 30 | 10.27 |
| " " | 121.8-122.2 | 30 | 9.72 |

100 gms. sat. solution of cinnamic acid in liquid ammonia contain 6.0 gms. $C_9H_8O_2$ at ? t°. (De Carli, 1927.)

Freezing-point data for mixtures of Cis and Trans Cinnamic acid are given by Eisenlohr and Metzner, 1937. Results are also given for mixtures of Cinnamic acid and:

Azobenzene(9)
Benzoic acid(3)(4)
Camphor(2)
Chlor acetic acid(4)
Dichlor acetic acid(4)
Dimethyl pyrone(4)
Dinitro phenol(6)
Dinitro benzene(6)
Erythritol(7)
Hydroquinone(6)
Naphthols(6)
Naphthylamine(5)
Nitro phenol(6)
Phenol(6)
Phenylene diamine(5)(8)
Phenyl propionic acid(1)
Picric acid(6)
Pyrocatechol(6)
Pyrogallol(6)
Resorcinol(6)
Toluidine(5)
Trichlor acetic acid(4)
Urea(5)

(1) Bruni and Gorni, 1899; (2) Efremow, 1913, 1914; (3) Kachler, 1870; (4) Kendall, 1914; (5) Kremann, Weber and Zechner, 1925; (6) Kremann, Zechner and Drazil, 1924; (7) Puschin and Dezelic, 1932; (8) Puschin and Dezelic, 1938; (9) Kremann and Zechner, 1925.

**PHENYL METHYL FUROXIME** $C_6H_5[(C_2N_2O)O]CH_3$.

Freezing-point data for mixtures of phenyl methyl furoxime and phenyl methyl dioxy diazine are given by Milone. 1929.

**HYDROXY CINNAMIC ACID** p (Coumaric Acid) $HOC_6H_4CH{:}CHCOOH$.

One liter sat. solution in water contains1.307 gm. p Hydroxy cinnamic acid at 25°.

One liter sat. solution of allo p-Hydroxy cinnamic acid in water contains 3.94 gms. at 25°. (Roth and Stoermer, 1913.)

β Phenyl Dibromo**PROPIONIC ACID** $C_2H_2Br_2(C_6H_5)COOH$.
100 cc. sat. sol. in carbon tetrachloride contain 0.124 gm. acid at 26°. (De Jong, 1909.)
100 cc. sat. sol. in petroleum ether contain 0.072 gm. acid at 26°. "

**n PHENYL VOLUNTAL** (Phenyl carbaminic acid tri chlor ethyl ester)
$CO(NHC_6H_5)OC_2H_2Cl_3$.

Freezing-point data are given by Pfeiffer and Seydel, 1928(a) for mixtures of n Phenyl voluntal with acetyl amino antipyrine, antipyrine, pyramidon and with sarcosine anhydride.

Acetyl **SALICYLIC ACID** (Aspirin) $CH_3COO.C_6H_4.COOH$, 1.2.

Solubility and Melting-Point Curves for Mixtures of Acetyl Salicylic Acid and Water, Determined by the Synthetic Method.
(Flaschner and Rankin, 1909.)

| Solubility Curve (Liquid Acid + $H_2O$). | | | M.-pt. Curve (Solid Acid + $H_2O$). | |
|---|---|---|---|---|
| t°. | Gms. $CH_3COO.C_6H_4.COOH$ per 100 Gms. | | t°. | Gms. $CH_3COOC_6H_4$-COOH per 100 Gms. Mixture. |
| | $H_2O$ Rich Layer. | Acid Rich Layer. | | |
| 25 | 4.8 | ... | 82.4 | 4.8 |
| 50 | 6 | 74 | 90.4 | 10 |
| 70 | 10 | 67 | 92.4 | 20 |
| 80 | 14 | 60 | 93.6 | 60 |
| 85 | 17.5 | 55 | 99 | 80 |
| 87.5 | 20 | 50 | 109.4 | 89.5 |
| 89 crit. temp. | | 35 | 131 | 100 |

100 gms. water dissolve 0.25 gm. aspirin at room temperature. (Squire and Caines, 1905.)
100 cc. 90% alcohol dissolve 20 gm. aspirin at room temperature. " "

100 gms. sat. sol. in water contain 0.577 gms. aspirin at 14° (Oliveri-Mandala, 1926.)
" 9.98 % solution of antipyrine contain 1.238 gms. aspirin at 14° (Oliveri-Mandala, 1926.)

100 gms. 86.5 % Glycerol ($d = 1.2326$) dissolve 0.71 gm. $CH_3COO.C_6H_4COOH$ at 20°
" 98.5 " ($d = 1.2645$) " 0.88 " " "
(Holm, 1921, 1922.)

100 gms. benzene dissolve 0.325 gm. acetyl salicylic acid at 25°.
" " $CCl_4$ dissolve 0.04 gm. acetyl salicylic acid at 25°. (Warren, 1933.)

Distribution of Acetyl Salicylic Acid at 25° Between :
(Smith, 1921, 1922.)

Water and Ethyl Ether.

| Millimols. $CH_3COO.C_6H_4COOH$ per liter of | | $\frac{C_2}{C_1}$. |
|---|---|---|
| $H_2O$ layer ($C_1$). | $(C_2H_5)_2O$ layer ($C_2$) | |
| 0.205 | 0.96 | 4.70 |
| 0.31 | 1.57 | 5.06 |
| 0.49 | 2.75 | 5.62 |
| 0.84 | 5.16 | 6.15 |
| 1.32 | 8.84 | 6.70 |

Water and Xylene.

| Millimols. $CH_3COO.C_6H_4COOH$ per liter of | | $\frac{C_2}{C_1}$. |
|---|---|---|
| $H_2O$ layer ($C_1$). | Xylene layer ($C_2$). | |
| 3.28 | 0.719 | 0.219 |
| 3.85 | 0.875 | 0.227 |
| 7.15 | 2.00 | 0.280 |
| 14.62 | 5.38 | 0.368 |
| 17.30 | 7.25 | 0.419 |

DISTRIBUTION OF ACETYL SALICYLIC ACID AT 25° BETWEEN:
(Smith and White, 1929.)

| Water and Chloroform | | Water and Toluene | |
|---|---|---|---|
| Gm. Mol. $C_9H_8O_4$ per liter | | Gm. Mol. $C_9H_8O_4$ per liter | |
| $H_2O$ layer | $CHCl_3$ layer | $H_2O$ layer | $C_8H_5CH_3$ layer |
| 0.0094 | 0.0440 | 0.00752 | 0.00310 |
| 0.0127 | 0.0764 | 0.00845 | 0.00370 |
| 0.0137 | 0.0882 | 0.00937 | 0.00436 |
| 0.0148 | 0.1023 | 0.01122 | 0.00581 |
| 0.0161 | 0.1200 | 0.01400 | 0.00818 |
| 0.0198 | 0.1810 | 0.01580 | 0.01010 |

**ETHYL DI NITRO BENZOATE** $3,5\text{-}(NO_2)_2C_6H_3COOC_2H_5$.

Results for the temperature-composition phase diagrams of the systems Ethyl-3,5-dinitro benzoate and butyl, 3,5-dinitro benzoate and ethyl 3,5-dinitro benzoate and methyl 3,5-dinitro benzoate are given by Caldwell and MacLean, 1933.

**SKATOLE** $C_9H_9N$.

Freezing-point data are given for mixtures of:

Skatole + Sarcosine anhydride (Pfeiffer and Angern, 1925.)
" + Tetra methyl diamino benzo phenone (Pfeiffer, Goebel and
" + Michler's ketone (Pfeiffer, 1924.) Angern, 1925.)

**METHYL INDOLE** α & β $CH_3NC_8H_6$.

Freezing-point data for mixtures of α and β Methyl indole with Sarcosine anhydride are given by Pfeiffer, Angern and Wang, 1927 and by Miers and Isaac, 1930.

Phenyl Brom Oxy**PROPIONIC ACIDS** (Optically Active Isomers).
SOLUBILITY OF EACH SEPARATELY IN CHLOROFORM AT 20°.
(Berner and Riiber, 1921.)

| Compound. | M. pt. | Gms. cmpd. per 100 gms. $CHCl_3$. |
|---|---|---|
| *r* β Phenyl β Brom α Oxy Propionic Acid | 165°.... | 0.30 |
| *d* » » » | 143..... | 1.00 |
| *l* » » » | 143..... | 1.00 |
| *r* β » β » » | 157..... | 0.90 |
| *d* » » » | 138..... | 2.60 |
| *l* » » » | 138..... | 2.60 |
| α Modification of β Phenyl α Brom α Oxy Acid | 125..... | 0.30 |
| β » » » » | 126.5... | 0.66 |
| *d* β Phenyl α Brom α Oxy Propionic Acid | 119..... | 0.37 |
| *r* » » » | 69..... | 0.51 |
| *l* » » » | 97..... | 1.77 |

*r* = racemic; *d* = dextro; *l* = laevo.
The authors also give the melting point curves of various mixtures of the isomers.

## HIPPURIC ACID $C_6H_5CO.NHCH_2COOH$.

| | | | | | |
|---|---|---|---|---|---|
| One liter | water | dissolves | 3.754 gms. | $C_9H_9O_3N$ at 25° | (Larsson, 1926.) |
| » | 0.025 *n* Na fumarate | » | 7.615 | » | » |
| » | 0.05 *n* » | » | 10.38 | » | » |
| » | 0.025 *n* Na tartrate | » | 7.418 | » | » |
| » | 0.05 *n* » | » | 9.712 | » | » |

### Solubility of Hippuric Acid in Aqueous Salt Solutiols at 25°.

(Larsson, 1927.)

| Aq. Solvent | $C_9H_9O_3N$ per liter | | Aq. Solvent | $C_9H_9O_3N$ per liter | |
|---|---|---|---|---|---|
| | Gm. Mols. | Gms. | | Gm. Mols. | Gms. |
| Water | 0.02095 | 3.752 | 0.05 normal Na formate | 0.0429 | 7.68 |
| 0.05 normal Na acetate | 0.0631 | 11.30 | 0.10 " " " | 0.0560 | 10.03 |
| 0.10 " " " | 0.0969 | 17.35 | 0.05 " Na chloracetate | 0.0301 | 5.39 |
| | | | 0.10 " " " | 0.0351 | 6.29. |

### Solubility of Hippuric Acid at 25° in Aqueous Solutions of:

Formic Acid. (Kendall, 1911.)

| Normality of Aq. HCOOH. | Gms. Hippuric Acid per Liter. |
|---|---|
| 0 | 3.67 |
| 1.25 | 3.61 |
| 2.5 | 3.72 |
| 5 | 4.08 |
| 10 | 4.77 |

Sodium Hippurate. (Sidgwick, 1910.)

| Normality of Aq. Sodium Hippurate. | Gms. Hippuric Acid per Liter. |
|---|---|
| 0 | 6.99(?) |
| 1 | 13.97(?) |

### Solubility of Hippuric Acid in Aq. Potassium Hippurate Solutions at 20°.

(Holtsema, 1898a.)

| Density of Solutions. | Gram Mols. per Liter Sol. | | Grams per Liter Solution. | | Solid Phase. |
|---|---|---|---|---|---|
| | $C_9H_9NO_3$. | $KC_9H_8NO_3$. | $C_9H_9NO_3$. | $KC_9H_8NO_3$. | |
| 1.002 | 0.0182 | 0 | 3.276 | 0.0 | $C_9H_9NO_3$ |
| 1.003 | 0.0163 | 0.011 | 2.919 | 2.39 | " |
| 1.008 | 0.0183 | 0.071 | 3.278 | 15.43 | " |
| 1.022 | 0.0234 | 0.254 | 4.191 | 55.18 | " |
| 1.114 | 0.064 | 1.36 | 11.47 | 295.4 | " |
| 1.182 | 0.131 | 2.21 | 23.46 | 480.1 | |
| 1.192 | 0.147 | 2.32 | 26.32 | 504.1 | $C_9H_9NO_3$ + $C_9H_9NO_3.KC_9H_8NO_3.H_2O$ |
| 1.195 | 0.153 | 2.40 | 27.40 | 521.4 | |
| 1.201 | 0.133 | 2.50 | 23.82 | 543.1 | $C_9H_9NO_3.KC_9H_8NO_3.H_2O$ |
| 1.239 | 0.084 | 3.01 | 15.04 | 654.0 | " |
| 1.282 | 0.068 | 3.57 | 12.18 | 775.7 | $C_9H_9NO_3.KC_9H_8NO_3.H_2O$ + $KC_9H_8NO_3$ |
| 1.282 | 0.065 | 3.58 | 11.60 | 777.8 | |
| 1.276 | 0.031 | 3.56 | 5.55 | 773.4 | $KC_9H_8NO_3$ |
| 1.277 | 0.011 | 3.55 | 1.917 | 771.3 | " |
| 1.277 | 0.00 | 3.56 | ... | 773.4 | " |

SOLUBILITY OF HIPPURIC ACID IN SEVERAL SOLVENTS.

| Solvent. | t°. | Gms. $C_6H_5CO.NHCH_2COOH$ per 100 Gms. Solvent. | Authority. |
|---|---|---|---|
| Water | 20–25 | 0.42 | (Dehn, 1917.) |
| Methyl Alcohol | 22 | 9.80 | (Timofeiew, 1894.) |
| Ethyl Alcohol | 22 | 5.20 | " |
| Propyl Alcohol | 23 | 2.80 | " |
| 50% Aqueous Pyridine | 20–25 | 88 | (Dehn, 1917.) |

100 gms. absolute alcohol dissolve 4.6 gms. $C_9H_9O_3N$ at 20°-25° (Pucher and Dehn, 1921.
» quinoline » 20.41 » »
» equi mol. mixture of alcohol and quinoline dissolve 23.10 gms. $C_9H_9O_3N$ at 20°-25°.

DISTRIBUTION OF HIPPURIC ACID AT 25° BETWEEN : (Smith, 1921, 1922.)

| Water and Ether. Millimols. $C_9H_9O_3N$ per liter of | | | Acetone and Glycerol. Millimols. $C_9H_9O_3N$ per liter of | | |
|---|---|---|---|---|---|
| $H_2O$ layer ($C_1$). | $(C_2H_5)_2O$ layer ($C_2$). | $\frac{C_2}{C_1}$. | Acetone layer A. | Glycerol layer G. | $\frac{A}{G}$. |
| 0.855 | 0.355 | 0.415 | 2.75 | 2.40 | 1.15 |
| 1.42 | 0.56 | 0.394 | 4.80 | 4.10 | 1.17 |
| 2.58 | 0.98 | 0.380 | 9.70 | 8.20 | 1.18 |
| 4.66 | 1.70 | 0.364 | 22.80 | 19.85 | 1.15 |
| 8.04 | 2.80 | 0.348 | | | |

## 3,5- DI IODO dl TYROSINE (dl-Iodo gorgoic Acid) $HOC_6H_2I_2CH_2CH(NH_2).COOH$.

SOLUBILITY OF 3,5 DI IODO dl TYROSINE IN WATER.
(Dalton and Schmidt, 1933.)

The following values were derived from a solubility equation calculated from a series of 12 very careful determinations at 7 different temperatures between 0 and 47°.

| t° | Gms. $C_9H_9O_3I_2N$ per 1000 gms. $H_2O$ | t° | Gms. $C_9H_9O_3I_2N$ per 1000 gms. $H_2O$ | t° | Gms. $C_9H_9O_3I_2N$ per 1000 gms. $H_2O$ |
|---|---|---|---|---|---|
| 0 | 0.204 | 30 | 0.769 | 60 | 2.90 |
| 5 | 0.255 | 35 | 0.959 | 65 | 3.61 |
| 10 | 0.318 | 40 | 1.197 | 70 | 4.51 |
| 15 | 0.396 | 45 | 1.493 | 75 | 5.62 |
| 20 | 0.494 | 50 | 1.862 | 100 | 17.00 |
| 25 | 0.617 | 55 | 2.32 | | |

## ETHYL NITRO BENZOATE p $C_6H_4(NO_2)COOC_2H_5$.

Freezing-point data for mixtures of ethyl p nitro benzoate and methyl p nitro benzoate are given by Caldwell and Mac Lean, 1933.
Results for mixtures of ethyl nitro benzoates and nitro mannitol are given by Urbanski, 1934.

## TRI NITRO MESITYLENE $C_6(NO_3)_3(CH_3)_3$.

Freezing-point data are given by Hammic and Hellican, 1938 for mixtures of tri nitro mesitylene with hexa methyl benzene and with naphthalene.

## β Phenyl**PROPIONIC ACID** (Hydrocinnamic Acid) $CH_2(C_6H_5).CH_2COOH$.

### Solubility of β Phenyl Propionic Acid in Water and in Benzene.

(Sidgwick and Ewbank, 1921 *a*.)

The determinations were made by the synthetic method and very careful attention was paid to all details necessary to insure accuracy.

Results for Water.

| t°. | Gms. $CH_3CH(C_6H_5)COOH$ per 100 gms. sat. sol. | Solid Phase. |
|---|---|---|
| 38.5..... | 94.92 | Solid |
| 34.0 tr. pt.. | — | Solid + liquid layers |
| 101.5..... | 80.3 | Liquid layers |
| 143.5..... | 60.16 | » |
| 150.0 crit. t. | 39.31 | » |
| 149.2..... | 19.31 | » |
| 119.9..... | 5.0 | » |

Resuls for Benzene.

| t°. | Gms. $CH_3CH(C_6H_5)COOH$ per 100 gms sat. sol. | Solid Phase. |
|---|---|---|
| 48.6.... | 100 | $CH_3CH(C_6H_5)COOH$ |
| 28..... | 78.87 | » |
| 13.8.... | 60.43 | » |
| —3.1.... | 40.20 | » |
| —1.8.... | 31.26 | $C_6H_6$ |
| +1.5. .. | 19.65 | » |
| 5.5 ... | 0.0 | » |

## β Phenyl**PROPIONIC ACID**

### Solubility in Water and in Aq. Normal Sodium β Phenylpropionate.

(Sidgwick, 1910.)

| Solvent. | Gms. $CH_2(C_6H_5)CH_2COOH$ per Liter Solution at: 11°. | 25°. |
|---|---|---|
| Water | 4.80 | 7.5 |
| 1 *n* aq. $CH_2(C_6H_5)CH_2.COONa$ | 7.65 | 172.5 (liquid layers formed) |

### Solubility of β Phenylpropionic Acid in Water and in Alcohols.

(Timofeiew, 1894.)

| Alcohol. | t°. | Gms. $CH_2(C_6H_5)$-$CH_2COOH$ per 100 Gms. Sat. Solution. |
|---|---|---|
| Water | 19 | 0.7 |
| Methyl Alcohol | −18.5 | 55.8 |
| " " | −16 | 57.6 |
| " " | 0 | 66.9 |
| " " | +19.6 | 82.8 |
| " " | 20 | 83.8 |
| Ethyl " | −18.5 | 46 |
| " " | −16 | 48 |

| Alcohol. | t°. | Gms. $CH_2(C_6H_5)$ $CH_2COOH$ per 100 Gms. Sat. Solution. |
|---|---|---|
| Ethyl Alcohol | +19.6 | 77.2 |
| " " | 20 | 78.8 |
| Propyl Alcohol | −18.5 | 35 |
| " " | −16 | 39 |
| " " | +19.6 | 73.4 |
| " " | 20 | 73.9 |
| Isobutyl Alcohol | 19.6 | 67.3 |

### Solubility of β Phenylpropionic Acid in Several Solvents.

(Herz and Rathmann, 1913.)

| Solvent. | $CH_2(C_6H_5)CH_2.COOH$ per Liter. Mols. | Gms. |
|---|---|---|
| Chloroform | 5.444 | 817.2 |
| Carbon Tetrachloride | 4.604 | 691.1 |
| Trichloro Ethylene | 5.140 | 771.6 |

| Solvent. | $CH_2(C_6H_5)CH_2COOH$ per Liter. Mols. | Gms. |
|---|---|---|
| Tetrachloro Ethylene | 4.725 | 709.2 |
| Tetrachloro Ethane | 5.430 | 815.1 |
| Pentachloro Ethane | 5.019 | 753.4 |

## Hydro **CINNAMIC ACID** $C_6H_5CH_2.CH_2COOH$.

### Distribution of Hydrocinnamic Acid at 25° Between: (Smith, 1921-1922.)

Water and Chloroform.

| Millimols. $C_9H_{10}O_2$ per liter of $H_2O$ layer ($C_1$). | $CHCl_3$ layer ($C_2$). | $\frac{C_2}{C_1}$. |
|---|---|---|
| 0.089 | 0.650 | 7.30 |
| 0.1058 | 0.835 | 7.90 |
| 0.134 | 1.190 | 8.87 |
| 0.177 | 1.770 | 10.00 |

Water and Xylene.

| Millimols. $C_9H_{10}O_2$ per liter of $H_2O$ layer ($C_1$). | $C_6H_4(CH_3)_2$ layer ($C_2$). | $\frac{C_2}{C_1}$. |
|---|---|---|
| 0.375 | 0.975 | 2.60 |
| 0.575 | 1.775 | 3.09 |
| 0.85 | 3.40 | 4.00 |
| 1.15 | 5.00 | 4.35 |

Freezing-point data are given for mixtures of hydro cinnamic acid (β phenyl propionic acid) +

Dimethyl pyrone (Kendall, 1914.)

Cinnamic acid (Bruni and Gorni, 1899.)

Phenyl acetic acid (Salkowski, 1885.)

**ETHYL BENZOATE** $C_6H_5COO(C_2H_5)$.

FREEZING-POINTS OF MIXTURES OF ETHYL BENZOATE AND TIN TETRACHLORIDE.
(Kournakov, Perelmouter and Kanov, 1916.)

| t° | Mol. % $SnCl_4$. | t°. | Mol. % $SnCl_4$. | t°. | Mol. % $SnCl_4$. | t°. | Mol. % $SnCl_4$ |
|---|---|---|---|---|---|---|---|
| 16..... | 5.0 | 45.0.... | 30.0 | 44.0.... | 40.0 | 46.4.... | 55.0 |
| 27.5. .. | 10.0 | 45.1.... | 31 5 | 42.0.... | 42.5 | 44.5.... | 60.0 |
| 33.8.... | 15.0 | 45.3.... | 33.0 | 41.8.... | 45.0 | 36.7.... | 70.0 |
| 39.5.... | 20.0 | 45.5*. . | 33.3 | 45.3.... | 48.0 | 26.5.... | 80.0 |
| 43.3.... | 25.0 | 45.3.... | 34.0 | 47.5**.. | 50.0 | 6.0.... | 90.0 |
| 44.0.... | 27.5 | 44.8.... | 38.0 | 47.3.... | 52.0 | —33.0.... | 100.0 |

* M. pt. of the Compound $SnCl_4.2C_6H_5COOC_2H_5$. ** M. pt. of the Compound $SnCl_4.C_6H_5COOC_2H_5$

100 gms. $H_2O$ dissolve 0.08 gm. $C_6H_5COO(C_2H_5)$ at 20°.
" " Aq. 0.4 normal sodium oleate solution (= 10.8 gm. Na oleate per 100 gms. solution) dissolve 5.4 gms. $C_6H_5COOC_2H_5$ at 20°. (Smith, 1932.)

Freezing-point data for mixtures of Ethyl benzoate and Tri chlor acetic cid are given by Kendall and Booge, 1916.

**METHYL TOLUATE** p $CH_3C_6H_4COOCH_3$.

Freezing-point data for mixtures of methyl p toluate and tri chlor acetic acid are given by Kendall and Booge, 1916.

**TOLUIDINE TRI CHLOR ACETATE** o and p $C_6H_4CH_3NH_2.CCl_3COOH.H_2O$.

SOLUBILITY OF o AND OF p TOLUIDINE TRICHLOR ACETATE IN WATER.
(Florence, 1927.)

| Compound | t° | Gms. $C_6H_4CH_3NH_2.CCl_3COOH$ per 100 gms. sat. sol. | Solid Phase |
|---|---|---|---|
| o Toluidine Trichlor acetate | 15 | 7.2 | o $C_6H_4CH_3NH_2CCl_3COOH.H_2O$ |
| " " " | 54 | 43.3 | |
| p " " " | 15 | 2.7 | p " |
| " " " | 57 | 38.4 | " |

**METHYL MANDELATES** $C_6H_5CH(OH)COOCH_3$.

Freezing-point data of mixtures of the optical isomeric methyl mandelates are given by Ross, 1936.

**TROPIC ACID** ($\alpha$ Phenylhydracrylic Acid) *i* and *l*, $C_6H_5.CH(CH_2OH)COOH$.

100 gms. sat. solution in $H_2O$ contain 1.975 gms. of the *i* acid at 20°.
100 gms. sat. solution in $H_2O$ contain 2.408 gms. of the *l* acid at 20°. } (Schlossberg 1900.)

**METHYL ANISATE** $CH_3OC_6H_4COOCH_3$.

Freezing-point data for mixtures of methyl anisate and tri chlor acetic acid are given by Kendall and Booge, 1916.

## PROPIONANILIDE $C_6H_5.NH(C_3H_5O)$.

### Solubility of Propionanilide in Aqueous Acetic Acid Solutions.

(Bradfield and Williams, 1929.)

The determinations were made by gradually heating mixtures of known weights of solute and solvent and noting the temperature at which the last trace of solid disappeared. The results were plotted and the values for selected temperatures obtained from the curve.

| Gms. $CH_3COOH$ per 100 gms. sat. solution at each temperature | Gms. $C_6H_5NH(C_3H_5O)$ per 100 gms. sat. solution at: | | | |
|---|---|---|---|---|
| | 20° | 25° | 30° | 35° |
| 0.0 | 0.18 | — | — | — |
| 26.9 | 0.87 | 1.05 | 1.26 | 1.52 |
| 52.4 | 4.15 | 5.10 | 6.36 | 8.05 |
| 76.8 | 18.0 | 21.5 | 28.6 | 37.4 |
| 85.0 | 26.6 | 32.5 | 40.9 | 51.7 |
| 91.3 | 33.5 | 41.0 | 50.0 | 61.4 |
| 99.0 | 35.5 | 40.8 | 48.7 | 61.6 |

F. pt. data for mixtures of propionanilide and acetanilide are given by Gilbert and Clarke, 1927 and by Skau and Rowe, 1935.)

## N-METHYL ACETANILIDE $CH_3CON(CH_3)C_6H_5$.

### Solubility of N-Methyl Acetanilide in Aqueous Acetic Acid Solutions.

(Bradfield and Williams, 1929.)

| Gms. $CH_3COOH$ per 100 gms. sat. sol. at each temp. | Gms. $CH_3CON(CH_3)C_6H_5$ per 100 gms. sat. solution at: | | | |
|---|---|---|---|---|
| | 20° | 25° | 30° | 35° |
| 0.0 (= $H_2O$) | 2.25 | 2.56 | 2.93 | 3.34 |
| 26.9 | 45.0 | 59 | 78 | 104 |
| 52.4 | 119 | 136 | 156 | 181 |
| 76.8 | 153 | 168 | 186 | 206 |
| 85 | 156 | 172 | 189 | 207 |
| 91.3 | 158 | 172 | 188 | 204 |
| 99.0 | 158 | 170 | 186 | 204 |

Freezing-point data are given for mixtures of:

N-Methyl acetanilide + Antipyrine (Angeletti, 1928; Giua, 1916.)
" " + Salol (Angeletti, 1928.)

## *p* ACETOTOLUIDE $CH_3CO.NHC_6H_4CH_3$

### Solubility of p Acetotoluide in Mixtures of Alcohol and Water at 25°.

(Holleman and Antusch, 1894.)

| Vol. % Alcohol. | Gms. per 100 Gms. Solvent. | Sp. Gr. of Solutions. | Vol. % Alcohol: | Gms. per 100 Gms. Solvent. | Sp. Gr. of Solutions. |
|---|---|---|---|---|---|
| 100 | 10.18 | 0.8074 | 50 | 1.82 | 0.9306 |
| 95 | 10.79 | 0.8276 | 45 | 1.41 | 0.9380 |
| 90 | 10.62 | 0.8440 | 40 | 0.96 | 0.9460 |
| 85 | 9.62 | 0.8576 | 35 | 0.66 | 0.9544 |
| 80 | 8.43 | 0.8685 | 25 | 0.31 | 0.9668 |
| 75 | 7.04 | 0.8803 | 20 | 0.23 | 0.9725 |
| 70 | 5.81 | 0.8904 | 15 | 0.16 | 0.9780 |
| 65 | 4.39 | 0.9021 | 5 | 0.13 | 0.9903 |
| 60 | 3.59 | 0.9115 | 0 | 0.12 | 0.9979 |
| 55 | 2.69 | 0.9207 | | | |

See remarks under α acetnaphthalide, p. 705

## Solubility of *p* Acetotoluide in Aqueous Solutions of Ethylalcohol

(Pleuger, 1925.)

The synthetic method of Alexejeff was used. Weighed amounts of the solvent and *p* Acetotoluide were sealed in small tubes and the temperature of complete solution determined. The individual determinations were plotted and the following results read from the curves.

| Wt. per cent $C_2H_5OH$ in solvent. | Gms. $CH_3CO.NHC_6H_4CH_3$ dissolved per 100 gms. sat. solution at | | | | | | |
|---|---|---|---|---|---|---|---|
| | 30°. | 50°. | 70°. | 90°. | 110°. | 130°. | 138° |
| 100 | 10.8 | 20.0 | 35.0 | 54.0 | 72.5 | 88.5 | 94.0 |
| 89.6 | 11.6 | 22.0 | 37.5 | 57.0 | 75.0 | 90.0 | .... |
| 70.6 | 7.5 | 17.0 | 35.0 | 57.5 | 80.0 | 93.0 | .... |
| 50.2 | 3.2 | 8.3 | 21.5 | 50.0 | 81.0 | 94.0 | .... |
| 30.1 | .... | 2.0 | 5.0 | 22.0 | 51.0 | 55.5 | .... |
| 10.0 | .... | .... | .... | 2.0 | 5.0 | 13.0 | .... |
| 0.0 ($H_2O$) | .... | .... | .... | .... | .... | .... | 97.5 |

## Solubility of *p* Acetotoluide in Mixtures of Ethylalcohol and Carbon Disulfide. (Pleuger, 1925.)

| Wt. per cent $C_2H_5OH$ in solvent. | Gms. $CH_3CO.NHC_6H_4CH_3$ dissolved per 100 gms. sat. solution at | | | | | | |
|---|---|---|---|---|---|---|---|
| | 30°. | 50°. | 70°. | 90°. | 110°. | 130°. | 140°. |
| 89.8 | 11.8 | 21.5 | 36.5 | 54.7 | 72.3 | 88.3 | .... |
| 70.5 | 14.0 | 23.5 | 37.5 | 55.5 | 72.0 | 87.4 | .... |
| 48.9 | 14.5 | 24.5 | 37.5 | 54.0 | 70.5 | 86.7 | .... |
| 30.3 | 12.5 | 21.5 | 34.5 | 51.5 | 68.0 | 85.5 | 94.0 |
| 10.0 | 5.0 | 11.5 | 23.5 | 41.5 | 61.5 | 82.0 | 92.5 |
| 0.0 ($CS_2$) | .... | .... | .... | 17.5 | 47.0 | 75.5 | 90.0 |

## Solubility of *p* Acetotoluide in Mixtures of Ethylalcohol and Carbon Tetrachloride.

| Wt. per cent $C_2H_5OH$ in solvent. | Gms. $CH_3CO.NHC_6H_4CH_3$ dissolved per 100 gms. sat. solution at | | | | | | |
|---|---|---|---|---|---|---|---|
| | 30°. | 50°. | 70°. | 90°. | 110°. | 130°. | 140°. |
| 80.4 | 10.6 | 14.7 | 34.0 | 52.0 | 71.0 | 87.5 | 94.5 |
| 60.2 | 10.3 | 19.0 | 32.0 | 49.5 | 67.5 | 85.5 | 93.5 |
| 40.0 | 9.5 | 17.5 | 29.0 | 45.0 | 63.0 | 82.5 | 92.5 |
| 20.0 | 6.8 | 13.5 | 23.5 | 38.0 | 57.0 | 78.5 | 91.0 |
| 0.0 ($CCl_4$) | .... | .... | .... | .... | 33.5 | 69.5 | 87.5 |

## Solubility of p Aceto Toluidide in Mixtures of Solvents at 25°.

(Mahieu, 1936.)

Results for mixtures of:

| $CCl_4 + C_6H_6$ | | $CS_2 + CH_3OH$ | | $CHCl_3 + (C_2H_5)_2O$ | | $C_6H_5NH_2 + C_6H_{12}$ | |
|---|---|---|---|---|---|---|---|
| Wt. % $C_6H_6$ in Solvent | Gms. $C_9H_{11}ON$ per 100 gms. Solvent | Wt. % $CH_3OH$ in Solvent | Gms. $C_9H_{11}ON$ per 100 gms. Solvent | Wt. % $(C_2H_5)_2O$ in Solvent | Gms. $C_9H_{11}ON$ per 100 gms. Solvent | Wt. % $C_6H_5NH$ in Solvent | Gms. $C_9H_{11}ON$ per 100 gms. Solvent |
| 0.0 | 0.54 | 0.0 | 0.11 | 0.0 | 5.07 | 0.0 | 0.13 |
| 25.1 | 0.38 | 23.8 | 17.3 | 25.6 | 2.34 | 28.4 | 1.9 |
| 47.7 | 0.30 | 52.9 | 26.9 | 51.6 | 1.50 | 45.4 | 5.0 |
| 74.6 | 0.15 | 75.1 | 26.5 | 75.2 | 1.16 | 72.6 | 11.9 |
| 100 | 0.10 | 100.0 | 14.4 | 100 | 1.06 | 100.0 | 11.0 |

## o ACETOTOLUIDE (o Methyl acetanilide) $CH_3CONHC_6H_4CH_3$.

### Solubility of o Acetotoluide in Various Solvents.

(Hall, Collett and Lazzell, 1933.)

The determinations were made by the synthetic method. The results are expressed in mol. percentage. They were plotted on a large scale and from the curves the following values for 5 degree intervals were obtained.

| | Gm. Mols. $CH_3CONHC_6H_4CH_3$ per 100 gm. mols. sat. solution in: | | | | | |
|---|---|---|---|---|---|---|
| $t^0$ | Methyl Alcohol $CH_3OH$ | Ethyl Alcohol $C_2H_5OH$ | n Propyl Alcohol $C_3H_7OH$ | n Butyl Alcohol $C_4H_9OH$ | iso Propyl Alcohol $CH_3CHOHCH_3$ | iso Butyl Alcohol $(CH_3)_2CHCH_2OH$ |
| 25 | 15.6 | 9.5 | — | 10.0 | — | 8.2 |
| 30 | 17.7 | 11.6 | 12.0 | 12.0 | 9.3 | 10.2 |
| 35 | 19.8 | 14.0 | 14.4 | 14.4 | 11.6 | 12.7 |
| 40 | 22.2 | 16.4 | 17.0 | 17.0 | 14.0 | 15.0 |
| 45 | 24.7 | 19.3 | 20.0 | 20.0 | 16.8 | 17.8 |
| 50 | 27.9 | 22.7 | 23.5 | 23.3 | 20.1 | 21.2 |
| 55 | 31.4 | 26.8 | 27.6 | 27.2 | 23.9 | 25.2 |
| 60 | 35.4 | 31.5 | 32.3 | 31.5 | 28.5 | 29.7 |
| 65 | 39.7 | 36.3 | 37.0 | 36.0 | 33.5 | 34.4 |
| 70 | 44.6 | 41.5 | 42.3 | 41.2 | 39.2 | 39.8 |
| 75 | 50.2 | 47.4 | 47.9 | 47.4 | 45.5 | 46.0 |
| 80 | 56.0 | 53.9 | 54.3 | 54.0 | 52.0 | 52.3 |
| 85 | 61.9 | 60.5 | 61.0 | 60.7 | 58.6 | 56.9 |
| 90 | 68.2 | 67.0 | 67.2 | 67.0 | 65.8 | 65.9 |
| 95 | 74.7 | 74.1 | 74.1 | 74.7 | 73.5 | 73.6 |
| 100 | 82.1 | 81.8 | 81.6 | 82.1 | 81.7 | 81.8 |
| 105 | 90.6 | 90.5 | 90.0 | 90.6 | 90.3 | 90.4 |
| 110.3 | 100 | 100 | 100 | 100 | 100 | 100 |

| | Gm. Mols. $CH_3CONHC_6H_4CH_3$ per 100 gm. mols. sat. solution in: | | | | |
|---|---|---|---|---|---|
| $t^0$ | Benzene $C_6H_6$ | Carbon Tetrachloride $CCl_4$ | Chloroform $CHCl_3$ | Acetone $(CH_3)_2CO$ | Ethyl Ether $(C_2H_5)_2O$ |
| 25 | — | — | 22.1 | 8.7 | 0.9 |
| 30 | — | — | 24.2 | 10.8 | 1.3 |
| 35 | 0.8 | 0.6 | 26.5 | 13.2 | 1.5 |
| 40 | 2.2 | 0.7 | 29.1 | 15.5 | 1.8 |
| 45 | 4.3 | 0.8 | 32.1 | 18.4 | 2.0 |
| 50 | 7.5 | 1.5 | 35.2 | 31.9 | 2.4 |
| 55 | 12.6 | 3.7 | 38.5 | 25.7 | 3.1 |
| 60 | 19.2 | 9.5 | 42.0 | 30.2 | 4.5 |
| 65 | 26.8 | 13.4 | 45.5 | 35.1 | 6.9 |
| 70 | 34.0 | 28.0 | 49.5 | 40.5 | 11.7 |
| 75 | 41.5 | 37.3 | 53.7 | 46.6 | 22.0 |
| 80 | 49.4 | 46.0 | 58.5 | 53.0 | 36.0 |
| 85 | 56.9 | 54.5 | 63.5 | 59.7 | 47.7 |
| 90 | 65.0 | 63.2 | 69.4 | 66.4 | 59.7 |
| 95 | 73.3 | 72.0 | 75.7 | 73.8 | 69.8 |
| 100 | 81.8 | 81.0 | 82.0 | 81.8 | 79.9 |
| 105 | 90.3 | 89.8 | 90.9 | 90.5 | 89.6 |
| 110.3 | 100 | 100 | 100 | 100 | 100 |

**NITROSO MESITYLENE** $NOC_6H_2(CH_3)_3$.

Freezing-point data are given by Hammick, Edwards, Illingworth and Suell, 1933, for mixtures of nitroso mesitylene with 4-nitroso m xylene, tri bromo nitroso benzene, o nitro nitroso benzene, o nitroso toluene, nitroso anisole and with nitroso benzene.

**DI METHYL AMINO BENZOIC ACID** p $(CH_3)_2NH_2C_6H_2COOH$.

Freezing-point data for mixtures of dimethyl amino benzoic acid and sarcosine anhydride are given by Pfeiffer, Angern and Wang, 1927.

**PHENYL URETHAN** (Carbanilic acid ethyl ester) $C_6H_5NHCOOC_2H_5$.

Freezing-point data for mixtures of phenyl urethan with pyramidon and with sarcosine anhydride are given by Pfeiffer and Seydel, 1928(a).

Meth**ACETIN** (*p* Acetanisidine, or *p* oxymethylacetanilide) $C_6H_4.OCH_3.NHCH_3CO$.

100 gms. $H_2O$ dissolve 0.19 gms. of the compound at 15° and 8.3 gms. at 100°.
(German Pharmacopoeia.)

β PHENYL dl **ALANINE** $C_6H_5CH_2CH(NH_2)COOH$.

SOLUBILITY OF β PHENYL dl-ALANINE IN WATER.
(Dalton and Schmidt, 1933.)

The following values were derived from a solubility equation calculated from a series of 29 very careful determinations at 10 different temperature between 0° and 75°.

| t° | Gms. $C_9H_{11}O_2N$ per 1000 gms. $H_2O$ | t° | Gms. $C_9H_{11}O_2N$ per 1000 gms. $H_2O$ | t° | Gms. $C_9H_{11}O_2N$ per 1000 gms. $H_2O$ |
|---|---|---|---|---|---|
| 0 | 9.97 (10.09) | 30 | 15.29 ( | 60 | 26.71 |
| 5 | 10.61 | 35 | 16.63 | 65 | 29.70 |
| 10 | 11.33 | 40 | 18.15 | 70 | 33.12 |
| 15 | 12.15 | 45 | 19.88 | 75 | 37.08 (36.96) |
| 20 | 13.07 | 50 | 21.87 (22.01) | 100 | 68.86 (65.3) |
| 25 | 14.11 (14.18) | 55 | 24.13 | | |

The density of an aqueous solution containing 13.83 gms. dl phenyl alanine per 1000 gms. $H_2O$ at 25° is 1.00055.
The results in parentheses are by Dunn, Ross and Read, 1933.
Data for the solubility of phenyl alanine in aqueous salt solutions at 20° are given by Würgler (1914) and Pfeiffer and Wurgler (1916).
100 cc of butyric acid dissolve 0.056 gm β phenyl alanine at 18
(v. Przylecki and Kasprzyk-Czaykowska, 1938.)

## β PHENYL *l*-ALANINE $C_6H_5CH_2CH(NH_2)COOH$.

### Solubility of β Phenyl l Alanine in Water.

(Dalton and Schmidt, 1935.)

The following values were derived from a solubility equation calculated from a series of 26 very careful determinations at 9 different temperatures between 0 and 65°.

| t° | Gms. $C_9H_{11}O_2N$ per 1000 gms. $H_2O$ | t° | Gms. $C_9H_{11}O_2N$ per 1000 gms. $H_2O$ | t° | Gms. $C_9H_{11}O_2N$ per 1000 gms. $H_2O$ |
|---|---|---|---|---|---|
| 0 | 19.83 | 30 | 32.13 | 60 | 52.04 |
| 5 | 21.50 | 35 | 34.82 | 65 | 56.40 |
| 10 | 23.29 | 40 | 37.73 | 70 | 61.11 |
| 15 | 25.24 | 45 | 40.89 | 75 | 66.24 |
| 20 | 27.35 | 50 | 44.31 | 100 | 99.00 |
| 25 | 29.65 | 55 | 48.02 | | |

The density of the sat. solution at 25° is 1.0035.

## *l* TYROSINE $HOC_6H_4CH_2CH(NH_2)COOH$.

### Solubility of *l* Tyrosine in Water.

(Dalton and Schmidt, 1933.)

The following values were derived from a solubility equation calculated from a series of 32 very careful determinations at 9 different temperatures between 0° and 60°.

| t° | Gms. $C_9H_{11}O_3N$ per 1000 gms. $H_2O$ | t° | Gms. $C_9H_{11}O_3N$ per 1000 gms. $H_2O$ | t° | Gms. $C_9H_{11}O_3N$ per 1000 gms. $H_2O$ |
|---|---|---|---|---|---|
| 0 | 0.196 (0.225) | 30 | 0.537 | 60 | 1.473 |
| 5 | 0.232 | 35 | 0.635 | 65 | 1.742 |
| 10 | 0.274 | 40 | 0.752 | 70 | 2.001 |
| 15 | 0.324 | 45 | 0.889 | 75 | 2.438 (2.378) |
| 20 | 0.384 | 50 | 1.052 (1.100) | 100 | 5.650 (4.92) |
| 25 | 0.453 (0.479) | 55 | 1.245 | | |

The results in parentheses are by Dunn, Ross, and Reed, 1933.

## *l* TYROSINE (*p* Hydroxy phenyl alanine) $C_6H_4OH.CH_2.CH(NH_2)COOH$.

### Solubility of *l* Tyrosine in Water and in Aqueous Salt Solutions.

The solutions were saturated by agitating a large excess of tyrosine with the solvent in a thermostat. The dissolved tyrosine was calculated from a micro nitrogen determination.

| Solvent. | t°. | Mols. $C_9H_{11}NO_3$ per liter. | Gms. $C_9H_{11}NO_3$ per liter. | Authority. |
|---|---|---|---|---|
| Water..... | 20.5 | 0.00246 | 0.446 | (von Euler and Rudberg, 1924-1925.) |
| » ..... | 21.0 | 0.00250 | 0.452 | (von Euler and Angern, 1924.) |
| Aq. 0.10*n* $LiNO_3$. | 20.5 | 0.00086 | 0.155 | (von Euler and Rudberg, 1924-1925.) |
| » 0.25*n* » . | 20.5 | 0.000071 | 0.0129 | » |
| » 0.05*n* NaCl.. | 20.5 | 0.00245 | 0.444 | » |
| » 0.10*n* » .. | 20.5 | 0.00239 | 0.433 | » |
| » 0.25*n* » .. | 20.5 | 0.00214 | 0.388 | » |

SIMULTANEOUS SOLUBILITY OF *l* TYROSIN AND *dl* LEUCINE IN WATER AND IN AQUEOUS 0.01 NORMAL HYDROCHLORIC ACID AT 21°. (von Euler and Rudberg, 1921.)

Saturation was obtained by constant agitation of a large excess of the amino acids with the solvents in a thermostat. The saturated solutions were analyzed by a determination of total nitrogen and a colorimetric estimation of the tyrosin, by means of the xanthoprotein reaction in alkaline solution.

| Solvent. | Gms. per liter of sat. sol. *l* Tyrosine. | Gms. per liter of sat. sol. *dl* Leucine. | Solid Phase. |
|---|---|---|---|
| Water | 0.338 | 9.87 | *l* Tyrosine + *dl* Leucine |
| Aq. 0.01 *n* HCl ($p_H = 1.74$) | 0.782 | 12.544 | » » |

The sat. solution in 0.01 *n* HCl had $p_H = 2.93$.

SOLUBILITY OF TYROSINE IN AQUEOUS SOLUTIONS OF DIFFERENT HYDROGEN ION CONCENTRATION AT 25°. (Sano, 1926.)

The desired $p_H$ concentration was secured with such acids and bases as form easily soluble salts with tyrosine. The solid phase in all cases was the amino acid. A large excess of tyrosine was shaken in a thermostat with the solvent and the saturated solution was analyzed by determination of the $p_H$ with a hydrogen electrode, and the nitrogen by the micro Kjeldahl method, using iodometric titration according to Bang.

| Solvent. | $p_H$ of sat. sol. | Gms. N per liter sat. sol. | Solvent. | $p_H$ of sat. sol. | Gms. N per liter sat. sol. |
|---|---|---|---|---|---|
| 0.1 *n* HCl + 0.9 *n* KCl | 1.07 | 0.41400 | 0.32 mol. sec. phosphate + 0.0025 mol. prim. phosphate | 7.41 | 0.04160 |
| 0.1 *n* » | 1.17 | 0.34070 | 0.066 mol. sec. phosphate | 8.39 | 0.04532 |
| 0.02 *n* » | 1.74 | 0.12460 | 0.005 *n* NaOH | 9.04 | 0.07022 |
| 0.01 *n* » | 2.25 | 0.07008 | 0.01 *n* » | 9.51 | 0.12070 |
| 1.0 *n* $CH_3COOH$ | 2.39 | 0.06056 | 0.02 *n* » + 0.9 *n* KCl | 9.63 | 0.15110 |
| 0.1 *n* » | 3.02 | 0.04131 | 0.05 *n* NaOH | 10.07 | 0.44260 |
| 0.016 *n* » + 0.1 *n* $CH_3COONa$ | 5.56 | 0.03658 | 0.10 *n* » | 10.25 | 0.83900 |
| » + 0.1 *n* $CH_3COONa$ + 0.9 *n* KCl | 5.60 | 0.03554 | 0.33 *n* » | 10.55 | 0.24520 |

The solubility minimum is at 0.03658 gm. N or 0.4726 gm. tyrosine per liter.

SOLUBILITY OF TYROSINE IN AQUEOUS SOLUTIONS AT 22°.
(Ando, 1926.)

| Solvent 1.0 n Aq. solution of: | Gms. $C_9H_{11}O_3N$ per liter sat. sol. | Solvent 1.0 n Aq. solution of: | Gms. $C_9H_{11}O_3N$ per liter sat. sol. |
|---|---|---|---|
| KCl | 0.411 | $CaCl_2$ | 0.501 |
| NaCl | 0.406 | $K_2SO_4$ | 0.406 |
| LiCl | 0.416 | KBr | 0.479 |
| $BaCl_2$ | 0.505 | KI | 0.564 |

One liter $H_2O$ dissolve 0.414 gm. $C_9H_{11}O_3N$ at 22°.

**MESITYLENE** 1,3,5-Tri methyl benzene $C_6H_3(CH_3)_3$.

100 gms. $H_2O$ dissolve about 0.002 gm. mesitylene (Horiba, 1917). The terms in which the author's results are expressed are not clearly defined.

Freezing-point data for mixtures of mesitylene and sulfur dioxide are given by De Carli, 1926.

Pseudo **CUMENE** 1,2,4-Tri methyl benzene $C_6H_3(CH_3)_3$ (b. pt. 168°–2°).

Freezing-point data for mixtures of $C_6H_3(CH_3)_3 + SO_2$ are given by De Carli, 1926

Acetone **PHENYL HYDRAZONE** $(CH_3)_2C.N_2HC_6H_5$.

DATA FOR THE SYSTEM ACETONE PHENYL HYDRAZONE + WATER ARE GIVEN BY BLANKSMA (1912).

The following results were obtained for the solubility of $(CH_3)_2C.N_2.HC_6H_5.H_2O$ in water.

| t°. | Gms. $(CH_3)_2C.N_2.HC_6H_5$ per 100 cc. Solution. | Solid Phase. |
|---|---|---|
| 0 | 0.090 | $(CH_3)_2C.N_2HC_6H_5.H_2O$ |
| 15 | 0.187 | " |
| 32.8 | 0.412 | " |

**METHYL ETHYL PHENOLS** $CH_3(C_2H_5)C_6H_3OH$.

Freezing-point data for mixtures of methyl ethyl phenols with cineole and with m-5-Xylidine are given by Morgan and Pettet, 1935.

**NITROSO PROPYL ANILINE** $NOC_6H_4NH(C_3H_7)$.

Freezing-point data for mixtures of nitroso propyl aniline and nitro propyl aniline are given by Jaeger and van Kregten, 1912.

**MESIDINE** (2,4,6 Tri methyl aniline) $(CH_3)_3C_6H_2NH_2$.

Freezing-point data for mixtures of mesidine and acetic acid are given by O'Connor, 1924.

**BENZYL ETHYL AMINE** $C_6H_5CH_2.NHC_2H_5$.

RECIPROCAL SOLUBILITY OF BENZYL ETHYL AMINE AND GLYCEROL.
(Parvatiker and Mc Ewen, 1924.)

This pair of compounds has an upper and a lower critical temperature of miscibility, hence the results. when plotted, give a complete circle.

| Temp. of miscibility. | | Gms. $C_6H_5CH_2.NHC_2H_5$ per 100 gms. sat. sol. | Temp. of miscibility. | | Gms. $C_6H_5CH_2.NHC_2H_5$ per 100 gms. sat. sol. |
|---|---|---|---|---|---|
| Lower. | Upper. | | Lower. | Upper. | |
| 61 | 177 | 10.14 | 51 | 281 | 54.89 |
| 50 | 251 | 18.07* | 63 | 277 | 76.10 |
| 50 | 267 | 24.48 | 71 | 253 | 82.50 |
| 50.1 | 279 | 40.06 | 85 | 144 | 87.85 |

DISTRIBUTION AT 25° OF : (Smith, 1921-1922.)

Benzyl Ethyl Amine Between :

| Water and Ethyl Ether | | | Water and Xylene. | | | Benzyl Ethyl Amine Acid Phthalate* Between Acetone and Glycerol. | | |
|---|---|---|---|---|---|---|---|---|
| Millimols. $C_6H_5CH_2NHC_2H_5$ per liter of | | | Millimols. $C_6H_5CH_2NHC_2H_5$ per liter of | | | Millimols. Acid Phthalate per liter of | | |
| $H_2O$ layer ($C_1$). | $(C_2H_5)_2O$ layer ($C_2$). | $\frac{C_2}{C_1}$. | $H_2O$ layer ($C_2$). | $C_6H_4(CH_3)_2$ layer ($C_3$). | $\frac{C_2}{C_1}$.* | Acetone layer (A). | Glycerol layer (G). | $\frac{A}{G}$ |
| 0.145 | 1.74 | 12.0 | 0.103 | 1.368 | 13.6 | 0.70 | 2.525 | 0.277 |
| 0.230 | 2.83 | 12.3 | 0.141 | 1.86 | 13.5 | 1.30 | 3.975 | 0.327 |
| 0.365 | 4.995 | 13.7 | 0.35 | 4.65 | 13.3 | 1.80 | 5.45 | 0.330 |
| 0.56 | 7.60 | 13.6 | 0.70 | 9.30 | 13.3 | 2.55 | 7.80 | 0.322 |
| 0.92 | 12.92 | 14.1 | 1.40 | 18.60 | 13.4 | 3.65 | 10.35 | 0.302 |

* See Note p. 213.

Pseudo**CUMIDINE** $(CH_3)_3.C_6H_2.NH_2$ (*s*, 5 Amino, 1. 2. 4. Trimethyl Benzene).

SOLUBILITY IN WATER.
(Lowenherz, 1898.)

| t°. | 19.4°. | 23.7°. | 28.7°. |
|---|---|---|---|
| Gms. ψ Cumidine per liter $H_2O$ | 1.198 | 1.330 | 1.498 |

## MESITYLENE PHOSPHINOUS ACID $(CH_3)_3C_6H_2P(OH)$.

SOLUBILITY OF MESITYLENE PHOSPHINOUS ACID (M. PT. 147°.35) IN WATER
(Creighton, 1926.)

Saturation was secured by constant agitation. The solutions were analyzed by titration with standard $Ba(OH)_2$ solution. The conductance of the solutions was also determined.

| t°. | Gms. $(CH_3)_3C_6H_2P(OH)_2$ per 100 gms. sat. sol. | t°. | Gms. $(CH_3)_3C_6H_2P(OH)_2$ per 100 gms. sat. sol. |
|---|---|---|---|
| 1.0..... | 0.289 | 45..... | 0.385 |
| 25..... | 0.299 | 65..... | 0.525 |
| 35..... | 0.324 | 85..... | 0.700 |

## Nor CAMPHOR $C_9H_{14}O$.

One liter of water dissolves 1.93 gms. Norcamphor at 15-20° (Rhode, 1922). The author used a stalogmometric method involving an estimation of the number of drops per unit of time in the case of a saturated solution and its dilutions, in comparison with similar determinations upon a series of solutions of known content.

## TRI ACETIN (Glycerol, tri acetate) $C_3H_5(OOCCH_3)_3$.

SOLUBILITY OF TRIACETIN IN BENZENE.
(Loskit, 1928.)

| t° | Gms. $C_9H_{14}O_6$ per 100 gms. sat. sol. | t° | Gms. $C_9H_{14}O_6$ per 100 gms. sat. sol. | t° | Gms. $C_9H_{14}O_6$ per 100 gms. sat. sol. |
|---|---|---|---|---|---|
| -38. | 84.20(1) | -6.8 | 46.90 | -0.2 | 24.96 |
| -26. | 77.14(1) | -5.0 | 42.19 | +1.3 | 18.60 |
| -14.6 | 63.87(1) | -3.0 | 35.81 | 1.8 | 16.28(1) |
| -14. | 62.13 | -1.9 | 30.24(1) | 2.0 | 15.91 |
| - 9. | 52.31 | -1.7 | 30.76 | 3.2 | 9.74 |
| - 7.2 | 47.53(1) | -1.6 | 29.90(1) | 3.51 | 8.73 |

(1) These determinations were made by the synthetic method and all others by the thermic method.

## ETHYL GLUTARIC ACID $(CH_2)_3(COOC_2H_5)_2$.

100 cc $H_2O$ dissolve 0.882 gm. $(CH_2)_3(COOC_2H_5)_2$ at 20°.
(Sobotka and Kahn, 1931.)

## AZELAIC ACID $C_7H_{14}(COOH)_2$.

SOLUBILITY IN WATER.
(Lamouroux, 1899.)

| t°. = | 0 | 15 | 20 | 35 | 50 | 65 |
|---|---|---|---|---|---|---|
| Gms. $C_7H_{14}(COOH)_2$ per 100 cc. solution = | 0.10 | 0.15 | 0.24 | 0.45 | 0.82 | 2 20 |

100 gms. 95% HCOOH dissolve 3.79 gms. azelaic acid at 19.4°. (Aschan, 1913.)

DISTRIBUTION OF AZELAIC ACID BETWEEN WATER AND ETHER AT 25°.
(Chandler, 1908.)

| Gms. $C_7H_{14}(COOH)_2$ per 1000 cc. | | Gms. $C_7H_{14}(COOH)_2$ per 1000 cc. | |
|---|---|---|---|
| Aq. Layer. | Ether Layer | Aq. Layer. | Ether Layer. |
| 0.06 | 0.47 | 0.40 | 5.83 |
| 0.10 | 1.10 | 0.50 | 7.40 |
| 0.20 | 2.71 | 0.58 | 8.65 |
| 0.30 | 4.26 | | |

100 gms. benzene dissolve 0.0092 gm. Azelaic acid at 25°.
(Verkade and Coops, Jr., 1930.)

HEXYL MALONIC ACID $CH(C_6H_{13})(COOH)_2$.

100 gms. $H_2O$ dissolve 0.415 gm. $CH(C_6H_{13})(COOH)_2$ at 25°.
" " $C_6H_6$ " 0.0306 " " " "

(Verkade and Coops, Jr., 1930a.)

Methyl **PELLETIERINE** $C_9H_{17}NO$.

SOLUBILITY OF METHYLPELLETIERINE IN WATER. (Tanret, 1920.)

Methylpelletierine is soluble in cold water in all proportions but when the temperature is raised the solution becomes cloudy at a definite temperature for each concentration, and at sufficiently high concentrations the alkaloid separates as droplets. The following results were obtained by adding successively increasing amounts of water to 1.0 gm. of methylpelletierine and determining the temperature of clouding.

| t° of clouding. | Gms. $C_9H_{17}NO$ per 100 gms. mixture. | t° of clouding. | Gms. $C_9H_{17}NO$ per 100 gms. mixture. | t° of clouding. | Gms. $C_9H_{17}NO$ per 100 gms. mixture. |
|---|---|---|---|---|---|
| 80..... | 4.8 | 53..... | 9.1 | 36.5..... | 66.6 |
| 74..... | 5.3 | 47..... | 11.1 | 37.5..... | 71.4 |
| 68..... | 5.9 | 42.5..... | 14.6 | 40..... | 77.0 |
| 63..... | 6.6 | 38..... | 20.0 | 43..... | 83.4 |
| 58..... | 7.7 | 35.5..... | 33.3 | 58..... | 90.9 |
| | | 35.5..... | 50.0 | | |

HEXA HYDRO MESITYLENE (1,3,5-Tri methyl cyclohexane) $C_6H_9(CH_3)_3$.

The critical solution temperature of mixtures of hexa hydro mesitylene and liquid sulfur dioxide is 30.5° and the reciprocal solubility curve at this temperature is practically flat between the concentrations 40 and 95 mol. percent $SO_2$. (Leslie, 1934.)

NONA NAPHTHENE (1,3,4-Tri methyl cyclohexane) $C_6H_9(CH_3)_3$.

The critical solution temperature of mixtures of nonanaphthene and liquid sulfur dioxide is 27° and the reciprocal solubility curve is practically flat between the concentrations 50 and 90 mol. percent $SO_2$. (Leslie, 1934.)

DIBUTYL KETONE $(C_4H_9)_2O$.

1000 gms. $H_2O$ dissolve 0.00357 gm. mols. $(C_4H_9)_2O$ at 10°, 0.00255 gm. mols at 30° and 0.00243 gm. mols. at 50°, as determined by analyzing the saturated solutions with the aid of a Zeiss interferometer. (Gross, Rintelen and Saylor, 1939.)

AMYL BUTYRATE $C_3H_7COOC_5H_{11}$.

100 cc $H_2O$ dissolve 0.06 cc amyl butyrate at 20°.
(Traube, 1884; Bancroft, 1895.)

PELARGONIC ACID $CH_3(CH_2)_7COOH$.

Results showing the distribution of pelargonic acid between water and olive oil at 23° are given by Bodansky, 1928.

**ETHYL OENANTHATE** $CH_3(CH_2)_5COOC_2H_5$.

100 cc $H_2O$ dissolve 0.029 gm. $CH_3(CH_2)_5COOC_2H_5$ at 20°. (Sobotka and Kahn, 1931.)

**NONANE** $CH_3(CH_2)_7CH_3$.

The critical solution temperature of mixtures of nonane and liquid sulfur dioxide is 32° and the reciprocal solubility curve at this temperature is practically flat between the concentrations 60 and 95 mol. percent $SO_2$. (Leslie, 1934.)

Freezing-point data for mixtures of nonane and octane are given by Smittenberg, Hoog and Henkes, 1938.

**CARVOXIME** $C_{10}H_4$:NOH *d*, *l* and *i*.

SOLUBILITY IN AQUEOUS ALCOHOL OF $d_{17.5} = 0.9125$ (51.6 PER CENT $C_2H_5OH$). (Goldschmidt and Cooper, 1898.)

The determinations were made by the synthetic method. On account of the slow rate at which melted carvoxime solidified on cooling below the melting point, in the tubes containing the synthetic mixtures, it was possible to obtain results which show the solubility curve for liquid carvoxime, in addition to the curves for dextro and inactive carvoxime. The curves for these latter intersect the curve for liquid carvoxime respectively at 51.7°, the m. pt. of dextro, and 70.5° the m.pt. of inactive carvoxime.

| Gms. Carvoxime. | Gms. Solvent. | Mols. Carvoxime per 100 Gms. Solvent. | t° of Solution. Solid. | t° of Solution. Liquid. | Solid Phase. |
|---|---|---|---|---|---|
| 0.0668 | 1.0868 | 0.0373 | 38.4 | 13.9 | *d* Carvoxime |
| 0.1232 | 1.0830 | 0.0689 | 45.8 | 31.9 | " |
| 0.2026 | 1.0218 | 0.1202 | 50.3 | 49.8 | " |
| 0.4040 | 1.0218 | 0.2396 | ... | 79.6 | " |
| 0.4128 | 0.8130 | 0.3077 | ... | 94.5 | " |
| 0.0657 | 1.0980 | 0.0363 | 54.2 | ... | *i* Carvoxime |
| 0.1212 | 1.0161 | 0.0723 | 62.5 | 33.7 | " |
| 0.2715 | 1.0129 | 0.1625 | 69.25 | 61.3 | " |
| 0.3755 | 1.0384 | 0.2192 | ... | 76.6 | " |
| 0.4496 | 0.7768 | 0.3409 | ... | 102.9 | " |

SOLUBILITY IN *d* LIMONENE. (Goldschmidt and Cooper, 1898.)

| t°. | Gms. $C_{10}H_4$:NOH per 100 Gms. *d* Limonene. | Solid Phase. | t°. | Gms. $C_{10}H_4$:NOH per 100 Gms. *d* Limonene. | Solid Phase. |
|---|---|---|---|---|---|
| 24.6 | 44.6 | *l* Carvoxime | 48 | 198.7 | *l* Carvoxime |
| 30 | 59.2 | *l* " | 49.4 | 199.7 | *d* " |
| 30.3 | 63.3 | *d* " | 55.1 | 325.1 | *l* " |
| 38.4 | 104.3 | *l* " | 55.9 | 346.6 | *d* " |
| 39.3 | 103.1 | *d* " | 58.8 | 560 | *d* " |
| 43.1 | 130.8 | *l* " | 63.2 | 1269.3 | *d* " |

Freezing-point data are given for mixtures of *d* and *l* carvoxime by Adriani, 1900 and by Beck, 1904.

**CHLORO TRINITRO NAPHTHALENE** $C_{10}H_4Cl(1)(NO_2)_3(2,4,5)$

SOLUBILITY IN METHYL AND IN ETHYL ALCOHOL. (Talen, 1927.)

| t° | Gms. $C_{10}H_4Cl(NO_2)_3$ per 100 cc of: $CH_3OH$ | Gms. $C_{10}H_4Cl(NO_2)_3$ per 100 cc of: $C_2H_5OH$ |
|---|---|---|
| 25 | 0.525 | 0.256 |

## CHLORO DINITRO NAPHTHALENE $C_{10}H_5Cl(1)\ (NO_2)_2(2.4)$

Solubility of 1-Chloro 2,4-Dinitro Naphthalene in Methyl and in Ethyl Alcohol.
(Talen. 1927.)

| t° | Gms. $C_{10}H_5Cl(NO_2)_2$ per 100 cc of: | |
|---|---|---|
| | $CH_3OH$ | $C_2H_5OH$ |
| 0 | 0.1056 | 0.0752 |
| 25 | 0.2378 | 0.1780 |

## TRI NITRO NAPHTHALENES $C_{10}H_5(NO_2)_3$.

100 gms. glycol diacetate ($CH_3\,CO\,O\,CH_2.CH_2\,O\,OC.CH_3$ b. pt. 188-189°.6) dissolve 0.9 gm. trinitro naphthalene at 25°. The sat. solution was analyzed by evaporating in a wagon pipet, but about 9 months were required for the determination. (Taylor and Rinkenbach, 1926.)

Freezing-point data for various binary and ternary mixtures of tri nitro di nitro and mono nitro naphthalenes are given by Pascal, 1920.

## DI NITRO NAPHTHALENES $C_{10}H_6(NO_2)_2$.

Freezing-point data for mixtures of dinitro and trinitro naphthalenes are given by Pascal, 1920 and by Urbanski and Kwiatkowski, 1934.

## BROMO NAPHTHALENES α and β $C_{10}H_7Br$.

Freezing-point data are given for mixtures of:

Bromo naphthalenes + Fluoro naphthalene (Klemm, Klemm and Schuemann, 1933.)
" " + Naphthalene " " " "
" " + Picric Acid (Jefremow, 1918.)
+ Styphnic Acid (Jefremow, 1919a.)

## CHLORO NAPHTHALENES α and β $C_{10}H_7Cl$.

Freezing-point data are given for mixtures of chloro naphthalenes and:

Bro
Bromo naphthalenes(4)
Fluoro naphthalenes(4)
Methyl naphthalene(1)
Naphthalene(4)
Naphthol(1)
Naphthylamine(1)
Picric acid(2)
Styphnic acid(3)

(1) Grimm, Gunther and Titus, 1931; (2) Jefremow, 1918; (3) Jefremow, 1919a; (4) Klemm, Klemm and Schiemann, 1933.

## FLUORO NAPHTHALENES α and β $C_{10}H_7F$.

Freezing-point data for mixtures of fluoro, bromo and chloro naphthalenes are given by Klemm, Klemm and Schiemann, 1933.)

Mono Nitro **NAPHTALENE** (α) $C_{10}H_7NO_2$ (α).

Solubility of α Mononitro Naphthalene (m. pt. 57°.3) in 95 per cent Ethyl Alcohol. (Crismer and Timmermans, 1920.)

The determinations were made by adding alcohol from a buret to weighed amounts of α mononitro naphthalene and observing the clouding point. The results were plotted and the following read from the curve.

| t°. | Gms. $C_{10}H_7NO_2$ (α) per 100 gms. sat. sol. | | t°. | Gms. $C_{10}H_7NO_2$ (α) per 100 gms. sat. sol. | |
|---|---|---|---|---|---|
| 26..... | 23.96 | (cryst.) | 41..... | 42.0 and 82.0 | liquid layers |
| 25.5... | 24.82 | » | 42..... | 45.0 » 80.5 | » |
| 25.5... | 26.3 | liquid layer | 43..... | 50.0 » 78.0 | » |
| 30.3... | 27.4 | « | 44..... | 58.0 » 73.5 | » |
| 34..... | 31.1 | » | 44.1 | crit. t. 65.0 » 65.0 | » |
| 38..... | 36.4 | » | 42..... | 87.4 | (cryst.) |
| 40..... | 40.0 | » | 44.5..... | 93.2 | » |

Freezing-point data are given for mixtures of Nitro naphthalenes and:

| | | |
|---|---|---|
| Camphor(15) | Nitro penta erythritol(12) | Tri nitro naphthalene(7) |
| Di nitro naphthalenes(7) | Paraffine(3)(8) | Tri nitro benzene(10) |
| Di phenyl amine(1)(2) | Picric acid(4)(10) | Tri nitro toluene(14) |
| Hydroquinone(9) | Pyrocatechol(9) | Tri methylene tri nitramine(13) |
| Naphthalene(2)(7)(8) | Resorcinol(9) | |
| Naphthylamine(11) | Styphnic acid(5) | Urethan(6) |
| Nitro mannitol(12) | Tetra nitro benzene(10) | |

(1) Battelli and Martinetti, 1885; (2) Bernoulli and Veillon, 1932; (3) Campetti and Delgrosso, 1913; (4) Jefremow, 1918; (5) Jefremow, 1919a; (6) Mascarelli, 1908; (7) Pascal, 1920; (8) Palazzo and Battelli, 1883; (9) Senden, 1923; (10) Shinomiya, 1940; (11) Tsakalotos, 1912; (12) Urbanski, 1933; (13) Urbanski and Rabek-Gawsonska, 1934; (14) Wogrinz and Vari, 1919; (15) Journiaux, 1912.

**NITROSO β NAPHTHOL** $C_{10}H_6(ON)OH$.

Solubility of Nitroso β Naphthol ($C_{10}H_6ONOH$) in Aqueous Solutions of Acetic Acid at 10°. (Nicolardot and Valli-Donan, 1918.)

| | | | | | |
|---|---|---|---|---|---|
| Gms. $CH_3COOH$ per 100 gms. solvent..... | 0.0 | 1.0 | 2.5 | 5.0 | 10.0 |
| » $C_{10}H_6ONOH$ per 100 gms. sat. sol.. | 0.017 | 0.022 | 0.023 | 0.031 | 0.065 |

**NAPHTHALENE** $C_{10}H_8$.

By means of an optical method, involving the use of an interferometer of the type described by Jamin (*Ann. chim. phys.*, 52, 171, 1858), it was found that 1000 cc. of $H_2O$ dissolve 0.022 gm. $C_{10}H_8$ at 15° and 0.040 gm. at 25°. (Mitchell, 1926.)

1000 cc. $H_2O$ dissolve 0.019 gm. $C_{10}H_8$ at 0° and 0.030 gm. at 25°. (Hilpert, 1916)

Results for the aqueous solubility of the solid solution system Naphthalene-β Naphthol at 25°, 65° and 78° are given by Wright and Wallace, 1936.

### Solubility of Naphthalene in Aqueous Solutions of Formic Acid.
(Christiansen, 1918.)

Note. — The determinations were made by mixing together the several ingredients and, after a period of standing in a thermostat, estimating from the presence or absence of solid, the composition corresponding to a saturated solution. Constant agitation was not employed.

At the higher concentrations the amount of naphthalene which just dissolved was determined.

| t°. | Gms. per 100 gms. sat. sol. HCOOH. | $C_{10}H_8$. |
|---|---|---|
| 0..... | 76.6 | 0.106 |
| 0..... | 84.5 | 0.188 |
| 0..... | 92.2 | 0.331 |
| 0..... | 97.7 | 0.477 |

| t°. | Gms. per 100 gms. sat. sol. HCOOH. | $C_{10}H_8$. |
|---|---|---|
| 25..... | 56.2 | 0.089 |
| 25..... | 67.8 | 0.168 |
| 25..... | 81.0 | 0.400 |
| 25..... | 91.6 | 0.715 |
| 25..... | 97.0 | 1.185 |

### Solubility in Acetic and Other Acids. (Timofciew, 1894.)

| Acid. | t°. | Gms. $C_{10}H_8$ per 100 Gms. Acid. |
|---|---|---|
| Acetic Acid | 6.75 | 6.8 |
| " " | 21.5 | 13.1 |
| " " | 42.5 | 31.1 |
| " " | 51.3 | 53.5 |
| " " | 60 | 111 |
| Butyric Acid | 6.75 | 13.6 |
| " " | 21.5 | 22.1 |
| " " | 60 | 131.6 |

| Acid. | t°. | Gms. $C_{10}H_8$ per 100 Gms. Acid. |
|---|---|---|
| Isobutyric Acid | 6.75 | 12.3 |
| Propionic Acid | 6.75 | 13.9 |
| " " | 21.5 | 23.4 |
| " " | 50 | 79.8 |
| Valeric Acid | 6.75 | 9.5 |
| " " | 21.5 | 17.7 |
| " " | 65 | 167.4 |

### Solubility of Naphthalene in Aqueous Solutions of Acetic Acid
(Christiansen, 1918.) See Note above

| t°. | Gms. per 100 gms. sat. sol. $CH_3COOH$. | $C_{10}H_8$. |
|---|---|---|
| 0°..... | 71.4 | 0.482 |
| 0 ..... | 81.1 | 1.2 |
| 0 ..... | 87.0 | 1.92 |
| 0 ..... | 89.9 | 2.58 |
| 25 ..... | 39.7 | 0.098 |
| 25 ..... | 47.5 | 0.195 |
| 25 ..... | 56.5 | 0.39 |
| 25 ..... | 60.1 | 0.486 |

| t°. | Gms. per 100 gms. sat. sol. $CH_3COOH$. | $C_{10}H_8$. |
|---|---|---|
| 25°..... | 68.7 | 0.967 |
| 25 ..... | 74.5 | 1.57 |
| 25 ..... | 79.4 | 2.42 |
| 25 ..... | 83.2 | 3.59 |
| 25 ..... | 84.7 | 4.81 |
| 25 ..... | 86.7 | 6.07 |
| 25 ..... | 86.9 | 7.3 |
| 25 ..... | 86.3 | 12.3 |

### Solubility of Naphthalene in Aqueous Solutions of Butyric Acid.
(Christiansen, 1918.)

| t°. | Gms. per 100 gms. sat. sol. $C_3H_7COOH$. | $C_{10}H_8$. |
|---|---|---|
| 0°..... | 75.3 | 4.12 |
| 0 ..... | 84.3 | 8.27 |
| 0 ..... | 86.9 | 9.67 |
| 25 ..... | 55.3 | 4.07 |

| t°. | Gms. per 100 gms. sat. sal. $C_3H_7COOH$. | $C_{10}H_8$. |
|---|---|---|
| 25°..... | 65.2 | 6.07 |
| 25 ..... | 75.0 | 15.38 |
| 25 ..... | 76.0 | 15.49 |
| 25 ..... | 76.3 | 20.7 |

### Solubility of Naphthalene in Aqueous Solutions of Propionic Acid.
(Christiansen, 1918.)

| t°. | Gms. per 100 gms. sat. sol. $C_2H_5COOH$. | $C_{10}H_8$. |
|---|---|---|
| 0°..... | 69.1 | 1.5 |
| 0 ..... | 78.6 | 3.0 |
| 0 ..... | 86.6 | 6.0 |
| 0 ..... | 89.6 | 9.97 |
| 25 ..... | 26 9 | 0.1 |
| 25 ..... | 38.1 | 0.3 |
| 25 ..... | 49.6 | 0.75 |

| t°. | Gms. per 100 gms. sat. sal. $C_2H_5COOH$. | $C_{10}H_8$. |
|---|---|---|
| 25°..... | 58.7 | 1.5 |
| 25 ..... | 67.3 | 3.0 |
| 25 ..... | 74.3 | 6.0 |
| 25 ..... | 80.0 | 10.92 |
| 25 ..... | 80.4 | 16.3 |
| 25 ..... | 78.8 | 20.95 |

## Solubility of Naphthalene in Aqueous Solutions of Alcohols.

(Chrisliansen, 1918.) See Note on preceding page.

### Aq. Methyl Alcohol.

| t°. | Gms. per 100 gms. sat. sol. $CH_3OH$. | $C_{10}H_8$. |
|---|---|---|
| 0°... | 80.7 | 0.91 |
| 0 ... | 86.87 | 1.83 |
| 0 ... | 95.32 | 3.72 |
| 0 ... | 100 | 4.1 |
| 25 ... | 43.10 | 0.11 |
| 25 ... | 56.5 | 0.34 |
| 25 ... | 65.1 | 0.75 |
| 25 ... | 69.52 | 1.18 |
| 25 ... | 79.2 | 2.4 |
| 25 ... | 86.5 | 4.55 |
| 25 ... | 90.86 | 8.77 |
| 25 ... | 91.0 | 8.84 |
| 25 ... | 100 | 9.9 |

### Aq. Ethyl Alcohol.

| t°. | Gms. per 100 gms. sat. sol. $C_2H_5OH$. | $C_{10}H_8$. |
|---|---|---|
| 0°... | 51.4 | 0.235 |
| 0 ... | 74.3 | 1.183 |
| 0 ... | 88.6 | 2.89 |
| 0 ... | 93.6 | 4.08 |
| 0 ... | 100 | 4.90 |
| 25 ... | 29.7 | 0.04 |
| 25 ... | 34.1 | 0.108 |
| 25 ... | 39.1 | 0.167 |
| 25 ... | 41.4 | 0.225 |
| 25 ... | 47.7 | 0.446 |
| 25 ... | 58.2 | 1.14 |
| 25 ... | 63.8 | 1.62 |
| 25 ... | 72.9 | 2.83 |
| 25 ... | 79.5 | 4.42 |
| 25 ... | 88.6 | 9.50 |
| 25 ... | 100 | 11.8 |

### Aq. Propyl Alcohol.

| t°. | Gms. per 100 gms. sat. sol. $C_3H_7OH$. | $C_{10}H_8$. |
|---|---|---|
| 25°... | 23.7 | 0.105 |
| 25 ... | 27.4 | 0.214 |
| 25 ... | 33.7 | 0.432 |
| 25 ... | 45.1 | 1.11 |
| 25 ... | 58.8 | 2.28 |
| 25 ... | 69.7 | 3.61 |
| 25 ... | 80.4 | 5.81 |
| 25 ... | 85.5 | 7.84 |
| 25 ... | 100 | 11.9 |

100 gms. 95% formic acid dissolve 0.30 gm. naphthalene at 18.5°. (Aschan, 1913.)
100 gms. 95% formic acid dissolve 3.44 gms. $\alpha$ nitronaphthalene at 18.5°. "

Data for equilibrium in the systems: naphthalene, phenol, water and naphthalene, succinic acid nitrile, water, determined by the synthetic method, are given by Timmermans (1907).

## Equilibrium in the System Naphthalene, Acetone, Water.

(Cady, 1898.)

An excess of naphthalene was added to each of a series of mixtures of water and acetone and the temperature determined at which a second liquid phase first appeared. Since an excess of naphthalene was present, the amount dissolved was not known. The following supplementary experiment was, therefore, required to ascertain the composition of the saturated solution in each case. "A weighed quantity of naphthalene was added to a known weight of the mixed liquids, the amount being just sufficient to cause the formation of two liquid phases. The consolute temperature of the system was then determined and the experiment repeated several times with different amounts of naphthalene. If the results are plotted, using the weights of naphthalene in a constant quantity of the mixed liquids as abscissas and the temperatures as ordinates, we shall get a series of curves. The composition of the liquid phase at the moment when the system passes from solid, solution and vapor to solid, two solutions and vapor is given by the point at which the prolongation of the curve for that particular mixture of acetone and water, cuts the ordinate for temperature at which the change takes place. This method requires no analysis and is of advantage in this case where ordinary quantitative analysis would be very difficult." Considerable difficulty was experienced in determining the consolute temperatures. It was necessary on account of the extreme volatility of the acetone to seal the mixtures in tubes.

The table of results, calculated with the aid of the determinations made as described above, is given on the following page.

TABLE SHOWING THE TEMPERATURES AT WHICH SOLUTIONS OF THE GIVEN COMPOSITIONS BEGIN TO SEPARATE INTO TWO LAYERS IN PRESENCE OF SOLID NAPHTHALENE. (Cady, 1898.)

(Calculated as described on preceding page.)

| t°. | Gms. per 100 Gms. Solution. Acetone. | Water. | Naphthalene. |
|---|---|---|---|
| 65.5 | 10 | 89.92 | 0.08 |
| 53.3 | 19.91 | 80 | 0.09 |
| 45 | 29.92 | 69.67 | 0.41 |
| 38 | 40.81 | 58.22 | 0.97 |
| 32.2 | 48.67 | 48.68 | 2.65 |
| 28.5 | 57.43 | 36.64 | 5.93 |
| 28.2 | 60.43 | 25.75 | 13.82 |

The isotherms for intervals of 10° lie so close together that they are practically indistinguishable for the greater part of their length.

SOLUBILITY OF NAPHTHALENE IN AQUEOUS AMMONIA.
(Hilpert, 1916.)

| Solvent. | Gms. $C_{10}H_8$ per 1000 Gms. Solvent at: 0°. | 25°. |
|---|---|---|
| Aq. 5% $NH_3$ | 0.030 | 0.044 |
| Aq. 10% $NH_3$ | 0.042 | 0.074 |
| Aq. 25% $NH_3$ | 0.064 | 0.162 |
| 100% $NH_3$ | 33 | 120 |
| Aq. 2% Pyridine | 0.082 | 0.245 |

DISTRIBUTION OF NAPHTHALENE BETWEEN METHYL ALCOHOL AND VASELINE AT 30°.
(Kozakewitch, 1935.)

| Gm. Mols. $C_{10}H_8$ per 1000 gms. $CH_3OH$(1) | Vaseline(2) | $\frac{1}{2}$ |
|---|---|---|
| 0.320 | 0.372 | 0.86 |
| 0.436 | 0.513 | 0.85 |

Results are also given showing the effect of the presence of LiBr, LiI, NaI, KI, $CdI_2$, $HgBr_2$ and $HgCl_2$ upon the above distribution.

SOLUBILITY OF NAPHTHALENE IN METHYL ALCOHOL
[Speyers, 1902; Ward, 1926.]

In the following table the densities are taken from a curve plotted from the results of Speyers and the solubilities from a curve plotted from the results of Ward.

| t°. | d of sat. sol. | Gms. $C_{10}H_8$ per 100 gms. $CH_3OH$. |
|---|---|---|
| 0..... | 0.8194 | 4.00 |
| 10..... | 0.812 | 5.6 |
| 20..... | 0.807 | 8.5 |
| 25..... | 0.805 | 10.0 |
| 30..... | 0.804 | 12.0 |
| 40..... | 0.805 | 18.0 |
| 50..... | 0.813 | 30.5 |
| 55..... | 0.82 | 41.5 |
| 60..... | 0.837 | 61.0 |
| 65..... | 0.870 | 120.0 |
| 67.5..... | 0.902 | 205 |
| 70..... | — | 460 |
| 71..... | — | 630 |
| 72..... | — | 900 |
| 73..... | — | 1200 |
| 74..... | — | 1700 |

## Solubility of Naphthalene in Ethyl Alcohol and in Propyl Alcohol.

(Speyers, 1902)

### Results for Ethyl Alcohol.

| t°. | *d* of sat. sol. | Gms. $C_{10}H_8$ per 100 gms. $C_2H_5OH$. |
|---|---|---|
| 0..... | 0.8175 | 5.1 |
| 10..... | 0.814 | 7.6 |
| 20..... | 0.810 | 10.2 |
| 25..... | 0.809 | 11.6 |
| 30..... | 0.809 | 13.4 |
| 40..... | 0.812 | 18.0 |
| 50..... | 0.822 | 37.0 |
| 60..... | 0.855 | 80.0 |
| 65..... | 0.890 | 125.0 |
| 70..... | 0.930 | 500.0 |

### Results for Propyl Alcohol.

| t°. | *d* of sat. sol. | Gms. $C_{10}H_8$ per 100 gms. $C_3H_7OH$. |
|---|---|---|
| 0..... | 0.8285 | 4.55 |
| 10..... | 0.824 | 5.9 |
| 20..... | 0.821 | 8.5 |
| 25..... | 0.820 | 10.0 |
| 30..... | 0.820 | 12.0 |
| 40..... | 0.823 | 17.5 |
| 50..... | 0.837 | 35.0 |
| 60..... | 0.867 | 100 |
| 65..... | 0.897 | 160 |
| 68.5..... | 0.933 | 361 |

## Solubility of Naphthalene in Normal Butyl Alcohol and in Carbon Tetrachloride. (Ward, 1926.)

### Results for Normal Butyl Alcohol.

| t°. | Gms. $C_{10}H_8$ per 100 gms. $CH_3(CH_2)_2CH_2OH$. | t°. | Gms. $C_{10}H_8$ per 100 gms. $CH_3(CH_2)_2CH_2OH$. |
|---|---|---|---|
| 11.7... | 7.28 | 56.9... | 65.80 |
| 22.0... | 10.54 | 63.2... | 131.6 |
| 24.3... | 11.44 | 68.1... | 269.2 |
| 31.6... | 15.43 | 70.1... | 402.2 |
| 35.6... | 18.23 | 71.7... | 552.5 |
| 46.5... | 32.26 | 73.9... | 887.6 |
| 52.3... | 46.33 | 76.0... | 1630.0 |

### Results for Carbon Tetra Chloride.

| t°. | Gms. $C_{10}H_8$ per 100 gms. $CCl_4$. | t°. | Gms. $C_{10}H_8$ per 100 gms. $CCl_4$. |
|---|---|---|---|
| 0.4... | 11.3 | 39.5.. | 53.08 |
| 6.0... | 13.9 | 46.9.. | 75.18 |
| 13.0... | 17.96 | 58.3.. | 142.6 |
| 19.5... | 23.12 | 64.8.. | 226.0 |
| 28.2... | 32.74 | 72.1.. | 503.4 |

## Solubility of Naphthalene in Several Alcohols.

(Sunier, 1930.)

The determinations were made by the synthetic method. The apparatus and precautions necessary to obtain accurate results are described.

Results for :

| Methyl Alcohol $CH_3OH$ | | Ethyl Alcohol $C_2H_5OH$ | | n Propyl Alcohol $C_3H_7OH$ | | iso Propyl Alcohol $CH_3CHOHCH_3$ | |
|---|---|---|---|---|---|---|---|
| t° | Gms. $C_{10}H_8$ per 100 gms. sat. sol. | t° | Gms. $C_{10}H_8$ per 100 gms. sat. sol. | t° | Gms. $C_{10}H_8$ per 100 gms. sat. sol. | t° | Gms. $C_{10}H_8$ per 100 gms. sat. sol. |
| 37.6 | 13.45 | 15.7 | 7.73 | 22.9 | 9.62 | 24.4 | 7.597 |
| 40.1 | 14.83 | 25.8 | 11.26 | 27.9 | 11.43 | 30.9 | 9.936 |
| 47.8 | 19.81 | 35.2 | 14.97 | 36.0 | 15.59 | 37.8 | 13.61 |
| 48.9 | 19.98 | 43.1 | 20.09 | 41.7 | 19.44 | 45.2 | 19.36 |
| 57.4 | 31.32 | 47.0 | 23.60 | 49.8 | 27.49 | 51.7 | 27.30 |
| 57.9 | 32.21 | 57.1 | 38.16 | 53.8 | 33.71 | 54.9 | 33.02 |
| 58.4 | 31.24 | 63.0 | 54.30 | 59.3 | 45.22 | 60.2 | 46.26 |
| 68.6 | 71.94 | 67.7 | 73.28 | 66.9 | 70.20 | 63.8 | 66.07 |
| | | | | 69.5 | 79.88 | 69.9 | 81.27 |

### Solubility of Naphthalene in Several Alcohols (Con.)

| Butyl Alcohol $CH_3(CH_2)_2CH_2OH$ | | Iso Butyl Alcohol $(CH_3)_2CHCH_2OH$ | | Sec. Butyl Alcohol $CH_3CH_2CHOHCH_3$ | | Tert. Butyl Alcohol $(CH_3)_3COH$ | |
|---|---|---|---|---|---|---|---|
| t° | Gms. $C_{10}H_8$ per 100 gms. sat. sol. | t° | Gms. $C_{10}H_8$ per 100 gms. sat. sol. | t° | Gms. $C_{10}H_8$ per 100 gms. sat. sol. | t° | Gms. $C_{10}H_8$ per 100 gms. sat. sol. |
| 34.7 | 15.19 | 19.5 | 6.37 | 28.7 | 10.82 | 31.6 | 10.77 |
| 47.6 | 25.49 | 36.3 | 12.76 | 34.9 | 14.35 | 37.8 | 14.49 |
| 57.8 | 41.83 | 40.9 | 15.57 | 40.5 | 18.63 | 47.3 | 23.61 |
| 68.4 | 74.27 | 50.4 | 24.88 | 46.4 | 25.03 | 50.2 | 27.76 |
| | | 60.3 | 45.09 | 57.3 | 45.35 | 57.8 | 43.61 |
| | | 63.1 | 54.10 | 60.6 | 54.05 | 62.4 | 57.31 |
| | | 70.2 | 80.83 | 68.8 | 73.06 | 66.6 | 71.64 |

### Solubility of Naphthalene in Chloroform. (Speyers, 1902)

| t°. | *d* of sat. sol. | Gms. $C_{10}H_8$ per 100 gms. $CHCl_3$. | t°. | *d* of sat. sol. | Gms. $C_{10}H_8$ per 100 gms. $CHCl_3$. |
|---|---|---|---|---|---|
| 0..... | 1.393 | 26.12 | 35..... | – | 80 |
| 10..... | 1.355 | 32.0 | 40..... | 1.205 | 94 |
| 20..... | 1.300 | 45.0 | 45..... | – | 112.0 |
| 25..... | 1.280 | 54.0 | 50..... | 1.150 | 132.0 |
| 30..... | 1.255 | 66 | 55..... | – | 158.0 |

### Solubility of Naphthalene in Acetone, Acetic Acid and in Aniline. (Ward, 1926.)

The determinations were made by the synthetic method. The results are given in terms of the weights of the ingredients of each mixture used for the determination. These have been calculated to grams of naphthalene per 100 gram of each solvent.

Results for Acetone.

| t°. | Gms. $C_{10}H_8$ per 100 gms. $CH_3COCH_3$. |
|---|---|
| 6.3.... | 32.0 |
| 14.3.... | 43.4 |
| 24.2.... | 64.9 |
| 32.6.... | 94.4 |
| 39.3.... | 127.4 |
| 47.2.... | 191.2 |
| 52.9.... | 258.7 |
| 58.5.... | 364.5 |
| 62.7.... | 496.7 |
| 67.2.... | 738.9 |
| 69.5.... | 926.0 |

Results for Acetic Acid.

| t°. | Gms. $C_{10}H_8$ per 100 gms. $CH_3COOH$. |
|---|---|
| 15.6.... | 9.73 |
| 23.5.... | 13.14 |
| 29.0.... | 16.79 |
| 36.5.... | 24.21 |
| 45.2.... | 37.33 |
| 50.4.... | 51.84 |
| 59.6.... | 110.3 |
| 64.9.... | 194.5 |
| 68.3.... | 297.0 |
| 75.1.... | 958.5 |

Results for Aniline.

| t°. | Gms. $C_{10}H_8$ per 100 gms. $C_6H_5NH_2$. |
|---|---|
| 0.6.... | 10.27 |
| 10.6.... | 15.5 |
| 12.9.... | 16.9 |
| 22.0.... | 25.0 |
| 29.9.... | 36.14 |
| 37.4.... | 52.73 |
| 50.8.... | 112.2 |
| 60.8.... | 230.4 |
| 65.4.... | 340.5 |
| 74.4.... | 1014.0 |

## Solubility of Naphthalene in Carbon Tetrachloride and in Carbon Disulfide.

(Schröder, 1893; Arctowski, 1895.)

| t° | Gms. $C_{10}H_8$ per 100 gms. sat. sol. in $CCl_4$ | Gms. $C_{10}H_8$ per 100 gms. sat. sol. in $CS_2$ | t° | Gms. $C_{10}H_8$ per 100 gms. sat. sol. in $CCl_4$ | Gms. $C_{10}H_8$ per 100 gms. sat. sol. in $CS_2$ |
|---|---|---|---|---|---|
| -108 | — | 0.62 | 20 | 20.0 | 36.3 |
| - 82 | — | 1.38 | 25 | 23.0 | 41.0 |
| - 50 | — | 2.3 | 30 | 26.5 | 46.0 |
| - 30 | — | 6.6 | 40 | 35.5 | 57.2 |
| - 10 | — | 14.1 | 50 | 47.5 | 67.6 |
| 0 | 9.0 | 19.9 | 60 | 62.5 | 79.2 |
| + 10 | 14.0 | 27.5 | 70 | 80.0 | 90.3 |

## Solubility of Naphthalene in Mixtures of Ether and Chloroform and of Ether and Carbon Disulfide at 25°.

(Mahieu, 1936.)

Results for mixtures of:

$(C_2H_5)_2O + CHCl_3$

| Gms. $(C_2H_5)_2O$ per 100 gms. Mixed Solvent | Gms. $C_{10}H_8$ per 100 gms. Solvent |
|---|---|
| 0.0 | 55.4 |
| 24.6 | 44.3. |
| 49.7 | 42.0 |
| 76.4 | 51.6 |
| 100.0 | 56.8 |

$(C_2H_5)_2O + CS_2$

| Gms. $(C_2H_5)_2O$ per 100 gms. Mixed Solvent | Gms. $C_{10}H_8$ per 100 gms. Solvent |
|---|---|
| 0.0 | 67.4 |
| 26.7 | 77.6 |
| 53.8 | 79.4 |
| 76.4 | 72.9 |
| 100.0 | 56.8 |

## Solubility of Naphthalene in Ethylene and Ethylidene Chlorides and Bromides.

(Sunier and Rosenblum, 1928.)

The determinations were made by the synthetic method observing the precautions described by Ward, 1926. The results were plotted and the following values for regular intervals of temperature were taken from the curves.

| t° | Gm. Mols. $C_{10}H_8$ per 100 gm. mols. sat. solution in: Ethylene Chloride $C_2H_4Cl_2$ | Ethylene bromide $C_2H_4Br_2$ | Ethylidene Chloride $CH_2CHCl_2$ | Ethylidene bromide $CH_2CHBr_2$ |
|---|---|---|---|---|
| 20 | — | 26.2 | — | 28.6 |
| 25 | 31.8 | 30.2 | — | 32.4 |
| 30 | 36.0 | 34.4 | 35.0 | 36.6 |
| 35 | 40.5 | 38.9 | 39.1 | 40.9 |
| 40 | 45.2 | 43.9 | 43.7 | 45.6 |
| 45 | 50.3 | 49.3 | 48.8 | 50.6 |
| 50 | 56.0 | 55.2 | 54.5 | 56.2 |
| 55 | 62.0 | 61.5 | 60.8 | 62.1 |
| 60 | 68.6 | 68.2 | 67.4 | 68.5 |
| 65 | 75.6 | 75.2 | 74.5 | 75.5 |
| 70 | 83.1 | 82.8 | 82.5 | 83.0 |
| 75 | 91.1 | 91.0 | 90.9 | 91.0 |

## Solubility of Naphthalene in Several Derivatives of Furfural.

(Sunier, 1931.)

The determinations were made by the synthetic method, the results plotted and the following values taken from the curves. The b. pts. of the solvents are at 25 mm pressure.

| | Gm. Mols. $C_{10}H_8$ per 100 gm. mols. sat. solution in: | | | | | |
|---|---|---|---|---|---|---|
| $t^o$ | Furfuryl Alcohol $C_4H_3OCH_2OH$ (b. pt. 75-6°) | Furfuryl Acetate $C_4H_3OCH_2OOCCH_3$ (b. pt. 84-5°) | Methyl Furoate $C_4H_3O.COOCH_3$ (b.pt. 83-4°) | Ethyl Furoate $C_4H_3OCOOC_2H_5$ (m.pt. 30-3°) | n Propyl Furoate $C_4H_3OCOOC_3H_7$ (b.pt. 105-7°) | n Butyl Furoate $C_4H_3OCOOC_4H_9$ (b.pt. 118-20°) |
| 20 | 7.28 | 19.9 | 19.2 | 24.6 | 26.0 | 27.2 |
| 25 | 8.49 | 23.3 | 22.7 | 28.1 | 29.7 | 30.9 |
| 30 | 10.48 | 27.2 | 26.7 | 32.1 | 33.8 | 35.1 |
| 35 | 11.94 | 31.6 | 31.3 | 36.5 | 37.9 | 37.9 |
| 40 | 14.46 | 36.7 | 36.6 | 41.5 | 43.0 | 44.5 |
| 45 | 17.58 | 42.5 | 42.5 | 47.1 | 48.3 | 49.8 |
| 50 | 21.9 | 49.1 | 49.1 | 53.1 | 54.3 | 55.5 |
| 55 | 27.5 | 56.5 | 56.5 | 59.7 | 60.7 | 61.8 |
| 60 | 35.2 | 64.4 | 64.4 | 66.8 | 67.8 | 68.4 |
| 65 | 47.4 | 72.6 | 72.6 | 74.7 | 75.0 | 75.3 |
| 75 | 85.7 | 90.0 | 90.0 | 90.8 | 91.0 | 91.3 |

## Solubility of Naphthalene in Several Organic Ethers and Oxides.

(Bennett and Philip, 1937.)

| Solvent | Formula | $t^o$ | Gm. Mols. $C_{10}H_8$ per 100 gm. mols. sat. solution |
|---|---|---|---|
| Di n butyl ether | $(C_4H_9)_2O$ | 42.6 | 37.73 |
| " " " " | " | 45.7 | 41.53 |
| " " " " | " | 52.9 | 50.78 |
| Ethyl n Propyl Ether | $C_2H_5.O.C_3H_7$ | 29.9 | 27.08 |
| " " " | " | 39.7 | 36.50 |
| " " " | " | 42.3 | 39.36 |
| Ethyl iso Propyl Ether | $C_2H_5.O.CH(CH_3)_2$ | 43.9 | 40.26 |
| " " " | " | 52.3 | 51.36 |
| Penta methylene oxide | $O(CH_2)_4CH_2$ | 26.4 | 34.21 |
| " " " | " | 30.1 | 37.05 |
| " " " | " | 40.2 | 46.08 |
| ββ′ Di methyl tri methylene oxide | $CH_2C(CH_3)_2CH_2O$ | 29.2 | 34.60 |
| " " " " " | " | 38.9 | 41.73 |
| αα′ Dimethyl tri methylene oxide | $CH_2CH_2C(CH_3)_2O$ | 33.8 | 30.10 |
| " " " " | " | 39.9 | 40.87 |
| " " " " | " | 44.7 | 45.57 |
| αα′ Methyl ethyl ethylene oxide | $CH_2C(CH_3)(C_2H_5)O$ | 27.4 | 32.56 |
| " " " " " | " | 38.2 | 42.23 |
| " " " " " | " | 46.6 | 50.52 |

## Solubility of Naphthalene in Benzene, in Chlorbenzene and in Nitrobenzene. (Ward, 1926.)

### Results for Benzene.

| t°. | Gms. $C_{10}H_8$ per 100 gms. $C_6H_6$. | t°. | Gms. $C_{10}H_8$ per 100 gms. $C_6H_6$. |
|---|---|---|---|
| 0..... | 28.0 | 40..... | 121 |
| 5..... | 33.0 | 45..... | 148 |
| 10..... | 39.0 | 50..... | 194 |
| 15..... | 47.0 | 55..... | 255 |
| 20..... | 56.0 | 60..... | 340 |
| 25..... | 67.5 | 65..... | 470 |
| 30..... | 81.5 | 70..... | 750 |
| 35..... | 100.0 | | |

### Results for Chlor Benzene.

| t°. | Gms. $C_{10}H_8$ per 100 gms. $C_6H_5Cl$. |
|---|---|
| 4.2.... | 23.87 |
| 8.8.... | 29.88 |
| 22.1.... | 47.04 |
| 29.4.... | 60.96 |
| 42.8.... | 102.3 |
| 49.0.... | 133.9 |
| 62.6.... | 286.5 |

### Results for Nitrobenzene.

| t°. | Gms. $C_{10}H_8$ per 100 gms. $C_6H_5NO_2$. |
|---|---|
| 2.9.... | 20.01 |
| 13.8.... | 29.29 |
| 24.0.... | 42.46 |
| 45.3.... | 99.24 |
| 60.2.... | 219.1 |
| 65.3.... | 313.4 |
| 71.8.... | 598.8 |

The above results in chloro benzene were used by Ward, 1934 to verify calculations of the ideal solubility of naphthalene.

## Solubility of Naphthalene in Hexane and in Toluene.

### Results for Hexane (1).

| t° | Gms. $C_{10}H_8$ per 100 gms. $CH_3(CH_2)_4CH_3$. | t°. | Gms. $C_{10}H_8$ per 100 gms. $CH_3(CH_2)_4CH_3$. |
|---|---|---|---|
| 8.7..... | 9.83 | 49.6..... | 76.10 |
| 14.8..... | 12.80 | 49.5..... | 76.47 |
| 19.5..... | 15.68 | 53.7..... | 105.6 |
| 27.7..... | 22.60 | 57.9..... | 148.1 |
| 28.5..... | 23.14 | 58.4..... | 153.8 |
| 30.8..... | 25.90 | 62.3..... | 218.9 |
| 32.2..... | 28.15 | 64.6..... | 288.1 |
| 36.1..... | 34.50 | 69.1..... | 511.1 |
| 38.0..... | 37.94 | 69.4..... | 523.5 |
| 42.3..... | 48.68 | 72.5..... | 817.4 |
| 45.8..... | 59.84 | | |

### Results for Toluene (2).

| t°. | Gms. $C_{10}H_8$ per 100 gms. $C_6H_5CH_3$. |
|---|---|
| —15..... | 15 |
| 0..... | 25 |
| 10..... | 34 |
| 20..... | 48 |
| 25..... | 58 |
| 30..... | 75 |
| 35..... | 83 |
| 40..... | 102 |
| 45..... | 129 |
| 50..... | 163 |
| 55..... | 210 |
| 60..... | 260 |
| 67.4..... | 389 |

(1) Ward, 1926. (2) Ward, 1926; Rhodes and Eisenhauer, 1927.

The previous results of Speyers, 1902, for the solubility of naphthalene in Toluene, are lower than the above values of Ward and Rhodes and Eisenhauer.

## Solubility of Naphthalene in Benzene, in Toluene and in Xylene.

(Schlapfer and Flocks, 1927.)

Results for:

### Benzene

| t° | Gms. $C_{10}H_8$ per 100 gms. $C_6H_6$ |
|---|---|
| -5.0 | 26.85 |
| 0 | 30.02 |
| 5.2 | 34.0 |
| 9.2 | 38.57 |
| 16.0 | 49.25 |
| 21.0 | 59.25 |
| 31.0 | 85.47 |
| 41.0 | 128.45 |

### Toluene

| t° | Gms. $C_{10}H_8$ per 100 gms. $C_6H_5CH_3$ |
|---|---|
| -26.0 | 10.15 |
| -19.0 | 13.27 |
| - 9.0 | 17.65 |
| 0 | 23.55 |
| 5.2 | 27.02 |
| 9.2 | 31.62 |
| 15.5 | 40.03 |
| 24.0 | 56.50 |
| 33.0 | 77.10 |
| 41.0 | 104.45 |

### Xylene (technical)

| t° | Gms. $C_{10}H_8$ per 100 gms. $C_6H_4(CH_3)_2$ |
|---|---|
| -26 | 2.77 |
| -18.0 | 6.90 |
| -14.0 | 9.29 |
| - 4.0 | 15.50 |
| 0 | 18.92 |
| 6 | 24.05 |
| 13 | 31.77 |
| 24 | 48.02 |
| 33 | 67.05 |
| 41 | 90.03 |

### Solubility of Naphthalene in Xylene.

(Rhodes and Eisenhauer, 1927.)

The temperatures of appearance of the first crystal and of disapqearanee of the last crystal in known mixtures of naphthalene and xylene were accurately determined and the mean taken as the temperature of solubility. The xylene was a mixture of *m* and *p* xylene practically free of *o* xylene.

| t°. | Gms. $C_{10}H_8$ per 100 gms. $C_6H_4(CH_3)_2$ *m* and *p*. | t°. | Gms. $C_{10}H_8$ per 100 gms. $C_6H_4(CH_3)_2$ *m* and *p*. | t° | Gms. $C_{10}H_8$ per 100 gms. $C_6H_4(CH_3)_2$ *m* and *p* |
|---|---|---|---|---|---|
| —22.0..... | 5.0 | 6.0..... | 25.0 | 35.0..... | 70.0 |
| —13.0..... | 10.0 | 11.2..... | 30.0 | 38.4..... | 80.0 |
| — 6.0..... | 15.0 | 19.5..... | 40.0 | 41.4..... | 90.0 |
| + 0.4..... | 20.0 | 25.6..... | 50.0 | 44.7..... | 100.0 |
| | | 30.6..... | 60.0 | | |

Similar results are given for the solubility of naphthalene in refined heavy solvent naphtha and heavy coal tar oil. Data for the effect of cresol and of quinoline upon the solubility of naphthalene in heavy solvent naphtha and heavy coal tar oil are also given.

### Solubility of Naphthalene in Tetrachlor Ethane under High Pressures, at 30°. (Cohen, de Meester and Moesveld, 1924-1925.)

| Pressure in atmospheres. | Gms. $C_{10}H_8$ per 100 gms. sat. sol. | Pressure in atmospheres. | Gms. $C_{10}H_8$ per 100 gms. sat. sol. |
|---|---|---|---|
| 0 | 35.07 | 750 | 23.33 |
| 250 | 30.26 | 1000 | 20.89 |
| 500 | 26.40 | | |

100 gms. Methyl Formate dissolve 33.9 gms. Naphthalene at 25°. (Kröber, 1919).

100 gms. Para Cymene (b. pt. 176-176.5) dissolve 14.22 gms. Naphthalene at 30° (Wheeler, 1920.)

100 gms. Quinoline dissolve 3.02 gms. Naphthalene at 20-25° (Pucher and Dehn, 1921.)

100 gms. Equimol mixture of Quinoline and Ethyl alcohol dissolve 4.69 gms. naphthalene at 20-25°. (Pucher and Dehn, 1921.)

Data for the solubility and vapor pressures of naphthalene in (1) fresh wash oil (2) used oil after steam distillation and (3) still residues, are given by Bunte and Pippig, 1923. The results are of interest chiefly in the illuminating gas industry.

### Solubility of Naphthalene in Tetralin and in Other Solvents.

(Weissenberger, 1927.)

Results for:

| Tetralin (1,2,3,4-Tetrahydro naphthalene $C_{10}H_{12}$) | | Decalin (Decahydro naphthalene $C_{10}H_{18}$) | | Hexalin (Cyclohexanol, $C_6H_{11}OH$) | | Methyl hexalin (Methyl cyclo-hexanol $CH_3C_6H_{10}OH$ | |
|---|---|---|---|---|---|---|---|
| t° | Gms. $C_{10}H_8$ per 100 gms. sat. sol. | t° | Gms. $C_{10}H_8$ per 100 gms. sat. sol. | t° | Gms. $C_{10}H_8$ per 100 gms. sat. sol. | t° | Gms. $C_{10}H_8$ per 100 gms. sat. sol. |
| -14 | 10 | 10 | 10.3 | 10 | 5.1 | 10 | 3.9 |
| - 6 | 15 | 20 | 20.3 | 20 | 11.7 | 20 | 8.8 |
| + 1 | 20 | 30 | 30.4 | 30 | 19.4 | 30 | 15.3 |
| 13 | 30 | 40 | 42.1 | 40 | 27.9 | 40 | 25.4 |
| 23 | 40 | 48 | 76.5 | 50 | 35.4 | 45 | 41.2 |
| 30 | 50 | | | | | | |
| 36 | 60 | | | | | | |

Experiments upon the solubility of naphthalene vapor in tetra hydro naphthalene and in gas oil, made by an aspiration method, are described by Mauras, 1937.

## Reciprocal Solubility of Naphthalene and:

(Hammick and Hellican, 1938.)

| Tri nitro mesitylene | | | Tri chloro tri nitro benzene | | |
|---|---|---|---|---|---|
| $t^\circ$ | Gm. Mol. $C_{10}H_8$ per 100 gm. mol. sat. solution | Solid Phase | $t^\circ$ | Gm. Mol. $C_{10}H_8$ per 100 gm. mol. sat. solution | Solid Phase |
| 232 | 0.0 | $C_6(CH_3)_3(NO_2)_3$ | 187.0 | 0.0 | $C_6H_2Cl_3(NO_2)_3$ |
| 229 | 10 | " | 183.0 | 7.0 | " |
| 220.7 | 20 | " | 171.2 | 20.0 | " |
| 216.5 | 27 | " | 158.3 | 31.0 | " |
| 205.2 | 37 | " | 149.8 | 37.0 | " |
| 192.5 | 49 | " | 135.0 | 48.0 | " + 2.1 |
| 177.0 | 60 | " | 134.2 | 51.0 | 2.1 |
| 160 | 71 | " | 130.0 | 55.0 | " |
| 135.5 | 81 | " | 127.2 | 59.0 | " |
| 122.0 | 84 | " | 108.9 | 71.0 | " |
| 95.3 | 90 | " | 89.0 | 80.0 | " |
| 78.5 | 98 | $C_{10}H_8$ | 74.3 | 90 | $C_{10}H_8$ |
| 80.0 | 100 | | 80.0 | 100 | |

2.1 = $2(C_6H_2Cl_3NO_2).C_{10}H_8$.

## Solubility of Naphthalene in Liquid Carbon Dioxide.

(Büchner, 1905-06.) (Synthetic Method used.)

| Crit. Temp. | Gms. $C_{10}H_8$ per 100 Gms. Sat. Sol. |
|---|---|
| 34.8 | 8 |
| 64 | 54 |
| 80 | 100 |

## Solubility of Naphthalene in Liquid Carbon Dioxide.

(Quinn, 1928a.)

The determinations were made in sealed tubes having two arms which permitted separating the saturated solution from the excess of $C_{10}H_8$. The volume of saturated solution was determined by graduations on the tube and the amount of $C_{10}H_8$ weighed after allowing the $CO_2$ to escape. The densities were determined in a specially disigned tube.

| $t^\circ$ | Density of liquid $CO_2$ | Density of sat. sol. | Gms. $C_{10}H_8$ per 1.0 gm. mol. $CO_2$ (= 44 gms.) | Gm. Mols. $C_{10}H_8$ per 100 gm. mols. sat. sol. |
|---|---|---|---|---|
| -21 | 1.031(-21°) | 1.040(-21°) | 0.231 | 0.180 |
| 0 | 0.927 | 0.938 | 0.479 | 0.372 |
| +10 | 0.858 | 0.872 | 0.658 | 0.511 |
| 20 | 0.770 | 0.790 | 0.854 | 0.662 |
| 25 | 0.710 | 0.740 | 0.901 | 0.698 |

100 gms. sat. solution of naphthalene in liquid sulfur dioxide contain about 23 gms. $C_{10}H_8$ at ? $t^\circ$. (DeCarli, 1927.)

## NAPHTHALENE

Freezing-point data are given for mixtures of Naphthalene and:

Amino phenols(4)
Benzene(7)(34)(49)
Benzil(5)
Benzilic acid(5)
Benzoic acid(15)(39)
Benzoic acid phenyl ester(5)
Benzoin(5)
Bi benzyl(24)
Bi phenyl(24)
Bromo naphthalene(16)
Camphene(65)
Camphor(11)(13)
Chlor acetic acid(26)(27)(57a)
Chlor acetic acid + phenol(26)
Chloro naphthalene(16)
Chloro nitro benzene(21)
Cineole(3)
Cresols(41)
Cyclohexane(25)
Di nitro benzenes(17)(21)(18)(23)(32)(36)(38)(46)
Di nitro phenol(47)
Dinitro toluene (21)(18)
Di acetyl tartrate(35)(45)
Di chloro benzene(30)
Di phenyl amine(44)(51)
" " " + benzene(7)
Di phenyl methane(29)
Di hydro naphthalene(56)
Ethylene bromide(2)(9)
Fluoro naphthalene(16)
Guaiacol(40)
Hydroquinone(19)
Iodoform(50)
Menthol(45)
Naphthol(43)(12)(55)(56)(51)(57)
Naphthol + benzene(7)
Naphthylamine(43)(31)(51)
Nitraniline(64)
Nitro benzene(18)(23)
Nitro naphthalene(6)(33)(35)
Nitro phenol(42)(18)(47)
Nitro mannitol(48)
Nitro penta erythritol(48)
Nitro toluenes(8)
Phthalic anhydride(53)
Phenanthrene(31)(51)(29)
Picric acid(18)(42)(52)
Phenol(6)(28)(59)(60)
" + chlor acetic acid (26)
Picryl chloride(10)(14)
Pyrocatechol(42)(19)
Pyridine(60)
Picramide(14)
Phenylene diamine(4)
(Palmitic acetic ester (58)
Paraffine(35)
Quinone(22)
Resorcinol(51)(19)
Salicylic acid(5)
Salol(1)
Styphnic acid(14)
Tetryl(15)
Toluidine(51)
Tri chlor acetic acid (17)
Tri nitro benzene(18)(23)
Tri nitro cresol(47)
Tri methyl carbinol(20)
Tri phenyl carbinol(20)
Tri nitro m xylene(15)
Tri nitro phenol(31)
Tri nitro aniline(10)
Tri nitro toluene(10)(18)
Thymol(6)(61)
Urea(37)
Urethan(54)
Stearic acid(62)
Sulfur(63)

(1) Angelletti, 1928; (2) Baud, 1912; (3) Bellucci and Grassi, 1913; (4) Bernoulli and Latter, 1933; (5) Bernoulli and Sarasin, 1930; (6) Bernoulli and Veillon, 1932; (7) Bruni, 1898; (8) Crockford and Simmons, Jr., 1933; (9) Dahms, 1895; (10) Grimm, Gunther and Titus, 1931; (11) Girard, 1891; (12) Hrynakowski and Szmyt, 1935e; (13) Journiaux, 1912; (14) Jefremow, 1918; (15) Jefremow and Tichomirowa, 1928; (16) Klemm, Klemm and Schiemann, 1933; (17) Kitran, 1924; (18) Kremann, 1904; (19) Kremann and Janetzky, 1912; (20) Kremann, Mauermann, Muller II and Rösler, 1922; (21) Kremann and Rodenis, 1906; (22) Kremann, Sutter, Sitte, Strzelba and Dobotzky, 1922; (23) Kurnakov, Krotkov and Oksman, 1915; (24) Lee and Warner, 1935; (25) Linard, 1925; (26) Mameli and Mannessier-Mameli, 1933; (27) Mameli and Mannessier; 1913; (28) Migliacci and Garuili, 1927; (29) Miolati, 1892; (30) Morris and Cook, 1935; (31) Milone and Rossignolli, 1932; (32) Olivari, 1911; (33) Pascal, 1920; (34) Pickering, 1893; (35) Palazzo and Battelli, 1883; (36) Puschin, 1926a; (37) Puschin and König, 1928; (38) Puschin and Rikovski, 1930; (39) Puschin and Wilowitsch, 1925; (40) Puschin and Vaic, 1927; (41) Rhodes and Hance, 1921; (42) Rheinboldt, Henning and Kirscheisen, 1925; (43) Rheinboldt and Kirscheisen, 1926; (44) Roloff, 1895; (45) Scheuer, 1910; (46) Skau, 1930; (47) Saposchinikow and Gelvich, 1903, 1904; (48) Urbanski, 1933; (49) Washburn and Read, 1915; (50) Wassilijew, 1916; (51) Vignon, 1891; (52) de Gee, 1916; (53) Monroe, 1919; (54) Vasilev, 1917; (55) Crompton & Whiteby, 1895; (56) Küster, 1895; (57) Miers and Isaac, 1908a; (57a) Miers and Isaac, 1908; (58) Battelli and Martinetti, 1885; (59) Yamamoto, 1908; (60) Hatcher and Skirrow, 1917; (61) Roloff, 1895; (62) Courtoune, 1882; (63) Bylert —; (64) Puschin and Grebenschikov, 1913; (65) Kurnakov & Jefremow, 1912.

**BROMO NAPHTHYLAMINE** $C_{10}H_6BrNH_2$.

Freezing-point data are given for mixtures of:

1 Bromo -2- naphthylamine + Picric acid (Hertel and Mischinat, 1926.)
" -4- " + 1,2,6 Dinitro phenol " "
" -4- " + " " " (Hertel and Van Cleef, 1928.)
4 " -1- " + Tri nitro anisole (Hertel and Römer, 1930.)
4 " -1- " + α[2,4,6-Tri nitro-phenoxy]-propionic ethyl ether " " " "

**BIPYRIDYL** $(C_5H_5N)_2$.

Freezing-point data are given for mixtures of bipyridyl and tri nitro benzene. (Smith and Watts, 1910.)

**β NAPHTHOL** $C_{10}H_7OH$.

Solubility in Water.

| t°. | Gms. β $C_{10}H_7OH$ per 100 cc. Sat. Sol. | Authority. |
|---|---|---|
| 12.5 | 0.044 | (Kuriloff, 1897.) |
| 25.1 | 0.074 | (Küster, 1895.) |
| 29.5 | 0.0876 | (Kuriloff, 1898.) |

Data for the solubility of isomorphous mixtures of β naphthol and naphthalene in water at 25.1° are given by Küster (1895).

Solidification Temperatures of Mixtures of β Naphthol and Salol.
(Bellucci, 1912.)

| t° of Solidification. | Gms. β $C_{10}H_7OH$ per 100 Gms. Mixture. | t° of Solidification. | Gms. β $C_{10}H_7OH$ per 100 Gms. Mixture. |
|---|---|---|---|
| 121.7 | 100 | 80 | 40 |
| 116.5 | 90 | 68 | 30 |
| 111 | 80 | 52.5 | 20 |
| 105 | 70 | 34 Eutec. | 10 |
| 97.5 | 60 | 38.5 | 5 |
| 88 | 50 | 42 | 0 |

100 gms. $C_6H_6$ dissolve 4.13 gm. β Naphthol at 25°.
" " $CCl_4$ " 0.442 " " " " "
(Warren, 1933.)

## Solubility of β Naphthol in Aqueous Solutions of Hydrochloric Acid at 25°. (Knox and Richards, 1919.)

| Equiv. Normalities. | | Equiv. Normalities. | | Equiv. Normalities. | |
|---|---|---|---|---|---|
| HCl. | $C_{10}H_7OH$. | HCl. | $C_{10}H_7OH$. | HCl. | $C_{10}H_7OH$. |
| 0.00 | 0.00524 | 4.343 | 0.00333 | 8.674 | 0.00307 |
| 1.466 | 0.00410 | 5.785 | 0.00319 | 11.47 | 0.00341 |
| 2.952 | 0.00360 | 7.122 | 0.00316 | | |

## Solubility of β Naphthol in Aqueous Solutions of Picric Acid at 29°. (Kuriloff, 1898.)

| Mols. × $10^3$ per 100 cc. Solution. | | Gms. per 100 cc. Solution. | | |
|---|---|---|---|---|
| $C_6H_2.OH(NO_2)_3$. | $C_{10}H_7OH$. | $C_6H_2OH(NO_2)_3$. | $C_{10}H_7OH$. | Solid Phase. |
| 0 | 609 | 0 | 0.0877 | β Naphthol |
| 54 | 615 | 0.0124 | 0.0886 | " |
| 68.5 | 620 | 0.0157 | 0.0894 | " +β Naphtholpicrate |
| 69 | 607 | 0.0158 | 0.0875 | β Naphtholpicrate |
| 69 | 597 | 0.0158 | 0.0860 | " |
| 88 | 494 | 0.0212 | 0.0712 | " |
| 100 | 390 | 0.0229 | 0.0562 | " |
| 196 | 180 | 0.0449 | 0.0259 | " |
| 308 | 105 | 0.0706 | 0.0151 | " |
| 933 | 8 | 0.2138 | 0.0011 | " +Picric Acid |
| 928 | 0 | 0.2126 | 0 | Picric Acid |

Data are also given for the distribution of β naphthol between water and benzene. The mean of the conc. in $C_6H_6$ layer divided by conc. in $H_2O$ layer is given as 67. The temperature is not given. The determination of the β naphthol was made by an iodine titration method.

The coefficient of distribution of β naphthol between $H_2O$ and $CHCl_3$ at 25° is; conc. in $H_2O$ ÷ conc. in $CHCl_3$ = 0.0171. (Marden, 1914.)

Data for the solubility of β naphthol, picric acid (naphthol picrate) and their mixtures in benzene, determined by the synthetic (sealed tube) method, are given by Kuriloff (1897a).

100 cc. 90% alcohol dissolve about 55 gms. β-$C_{10}H_7OH$ at 15.5°. (Greenish and Smith, 1903.)

100 gms. 95% formic acid dissolve 3.11 gms. β $C_{10}H_7OH$ at 18.6°. (Aschan, 1913.)

## NAPHTHOLS

Freezing-point data are given for mixtures of Naphthols and:

Acetamide(23)
Acetanilide + Salicylic Acid(16)
Acetanilide + Urea(16)
Aceto phenone(36)
Anthracene(57)
Antipyrine(26)(50)
Aniline(28)
Amino phenols(28)
Azobenzene(40)
Benzoic acid(3)
Benzal acetophenone(45)
Benzhydrol(27)
Benzamide(23)
Benzo phenone(32)
Carbazole(31)
Camphor(11)
Chalcone(46)
Chloro naphthalene(15)
Cinnamic aldehyde(39)
Cineole(4)
Cyclic oxide from methyl diphenate(7)
Chlor acetic acid(44)
Cinnamic acid(33)
Di methyl amino benzo acetophenone(45)(46)
Di methyl amino-p-methoxy aceto phenone(45)
Di methyl amino benzo phenone(45)(46)
Di methyl pyrone(20)
Di phenyl methane(25)
Di phenyl amine(34)(57)
Di nitro toluene(14)
Di nitro " + naphthols(56)
Di nitro benzene(14)
Di methyl oxalate(33)
Di anisol acetone(46)
Ethylene bromide(8)
Ethylene " + picric acid(8)
Ethyl oxalate(33)
Fenchon(24)
Iodo biphenyl(47)
Methylene dioxy chalcone(1)
" " . " + picric acid(1)
Methylene dioxy benzal aceto phenone(2)
Methyl naphthalene(54)
Naphthalene(10)(17)(41)(42)(51)(56)
Naphthols(57)(10)
" + Dinitro toluene(56)
Naphthylamine(57)(38)(18)(51)(52)
Nitro benzene + quinone(37)
Nitro benzaldehyde(12)(13)
Oxy benzaldehyde(29)
Phenyl tetra methyl tetra hydro pyran(7)
Phenol(43)
Phenylene diamine(38)
Phenyl acrylo phenone(45)
Picric Acid(1)(21)
Picric Acid + Ethylene bromide(8)
Quinone(37)
" + nitro benzene(37)
Resorcinol(57)
Sarcosine anhydride(48)
Salol(50)
Salicylic acid(9)(3)
" " + Acetanilide(16)
Salol + Sulfonal(5)
Styryl ketone(46)
Sulfonal(5)
Sulfonal + Salol(5)
Salicylic aldehyde(39)
Succinic acid(27)(33)
Succinimide(24)
Styphnic acid(19)
Toluidine(28)(38)(49)(57)
Tetra methyl-p-diamino benzo phenone(46)
Tetra methyl phthalan (7)
Tri chlor acetic acid (22)(21)
Tri nitro toluene(14)
Tri nitro phenol(2)
Tri phenyl carbinol(35)
Tri phenyl methane(30)
Urea(53)
" + acetanilide(16)

(1) Asahina, 1934a; (2) Asahina, 1934; (3) Bartholomew and Wark, 1926; (4) Bellucci and Grassi, 1913; (5) Bianchini, 1914; (7) Bennett and Wain, 1936; (8) Bruni, 1898; (9) Castiglioni, 1937; (10) Crompton and Whiteby, 1895; (11) Caille, 1909, 1910; (12) Dischendorfer, 1928; (13) Dischendorfer and Nesitka, 1928; (14) Giua and Marcellino, 1920; (15) Grimm, Gunther and Titus, 1931; (16) Hrynakowski and Szmyt, 1935c; (17) Hrynakowski and Szmyt, 1935b; (18) Hrynakowski and Szymt, 1934; (19) Jefremow, 1934; (20) Kendall, 1914; (21) Kendall, 1916; (22) Kitran, 1924; (23) Kremann and Auer, 1918; (24) Kremann and Dietrich, 1923; (25) Kremann and Fritsch, 1920; (26) Kremann and Haas, 1919; (27) Kremann and Drazil, 1924; (28) Kremann, Lupfer and Zawodsky, 1920; (29) Kremann and Pogantsch, 1923; (30) Kremann, Odelga and Zawodsky, 1921; (31) Kremann and Slovak, 1920; (32) Kremann and Zechner, 1918; (33) Kremann, Zechner and Drazil, 1924; (34) Kremann and Schadinger, 1919; (35) Kremann and Wlk, 1919; (36) Kremann and Marktl, 1920; (37) Kremann, Sutter, Sitte, Strzelba and Dobolzky, 1922; (38) Kremann and Stroschneider, 1918; (39) Kremann and Zechner, 1925; (40) Kremann, Zechner and Weber, 1924; (41) Küster, 1895; (42) Miers and Isaac, 1908a; (43) Migliacci and Garguilo, 1927; (44) Mameli and Coccini, 1923; (45) Pfeiffer, 1924; (46) Pfeiffer, Goebel and Angern, 1925; (47) Pfeiffer, Schmitz and Inoue, 1929; (48) Pfeiffer, Angern and Wang, 1927; (49) Philip 1903; (509 Quercigh and Cavagnari, 1912; (51) Rheinboldt and Kirscheisen, 1926; (52) Rheinboldt, Henning and Kirscheisen, 1925; (53) Puschin and König, 1928; (54) Skau, 1930; (56) Trifonow and Tscherbow, 1929; (57) Vignon, 1891.

**DIOXY NAPHTHALENES** (Naphthalenediols) $C_{10}H_6(OH)_2$.

Freezing-point data for mixtures of Dioxy naphthalenes with Benzamide, Naphthylamines and Phenylene diamines are given by Kremann, Hemmelmayr and Riemer, 1922. Results for mixtures of Dioxy naphthalenes with succinimide are given by Kremann and Dietrick, 1923.

**FURFURALIZINE** $C_4H_3OCH{:}N{-}N{:}CHC_4H_3O$

Freezing-point data for mixtures of Furfuralizine with Benzalazine and with Thiophenalazine are given by Pascal, 1914.

**β NAPHTHALENE SULFONIC ACID** $C_{10}H_7SO_3H$.

SOLUBILITY IN AQUEOUS HYDROCHLORIC ACID AT 30°.
(Masson, 1912.)

| $d_{30}^{30}$ of Sat. Solution. | Mols. per Liter Sat. Sol. | | Gms. per Liter Sat. Sol. | |
|---|---|---|---|---|
| | HCl. | $C_{10}H_7SO_3H$. | HCl. | $C_{10}H_7SO_3H$. |
| 1.1925 | 0 | 3.263 | 0 | 679 |
| 1.1653 | 1.291 | 2.470 | 47.08 | 514 |
| 1.1553 | 1.826 | 2.117 | 66.59 | 440.6 |
| 1.1115 | 4.017 | 0.762 | 146.5 | 158.6 |
| 1.1197 | 7.232 | 0.089 | 263.7 | 18.5 |
| 1.1569 | 0.88 | 0.063 | 360.3 | 13.1 |

SOLUBILITY OF α AND β NAPHTHYLAMINE SALTS OF NAPHTHALENE MONO AND DISULFONIC ACIDS, IN 0.01 NORMAL HYDROCHLORIC ACID. (Wales, 1922.)

The solutions were saturated by constant agitation in a thermostat for one day. Freshly prepared mixtures were used in all cases. The saturated solutions were analyzed by evaporation to dryness and weighing the residue. The author does not state clearly that 0.01 *n* HCl was used as solvent in all cases, but this is apparently the case since it is mentioned that the compounds hydrolyze in pure water and that 0.01 *n* HCl is necessary to prevent hydrolysis. Results are given for intervals of 5° between 25° and 98°.

| | Grams each compound determined separately per 100 gms. solvent at | | | | | |
|---|---|---|---|---|---|---|
| | 25°. | 35. | 45°. | 55°. | 70°. | 90°. |
| α Naphthylamine salt of : | | | | | | |
| Naphthalene α Mono sulfonate. | 0.3125 | 0.5007 | 0.7340 | 0.9733 | 1.368 | 2.028 |
| » β » | 0.2039 | 0.2985 | 0.4420 | 0.6243 | 0.8493 | 2.132 |
| β Naphthylamine salt of : | | | | | | |
| Naphthalene β Mono sulfonate. | 0.0563 | 0.0736 | 0.1008 | 0.1434 | 0.2393 | 0.4667 |
| » α » . | 0.1735 | 0.2533 | 0.3985 | 0.6044 | 1.141 | 2.980 |
| Ferrous salt of Naphthalene β Mono sulfonate..... | 0.3022 | 0.4233 | 0.6174 | 0.9171 | 1.393 | 2.882 |
| α Naphthylamine salt of : | | | | | | |
| Naphthalene 1.5 Di sulfonate. | 0.0605 | 0.0853 | 0.1033 | 0.1563 | 0.2212 | 0.4010 |
| » 1.6 » . | 2.290 | 4.210 | 9.590 | – | – | – |
| » 2.6 » . | 0.517 | 0.7178 | 1.005 | 1.288 | 2.062 | 3.770 |
| » 2.7 » . | 0.8689 | 1.162 | 1.599 | 2.405 | 10.30 | 87.70 |
| β Naphthylamine salt of : | | | | | | |
| Naphthalene 1.5 Di sulfonate. | 0.0727 | 0.0887 | 0.1233 | 0.1701 | 0.2562 | 0.4427 |
| » 1.6 » . | 0.2952 | 0.4934 | 0.6789 | 0.9546 | 1.852 | 4.019 |
| » 2.6 » . | 0.0296 | 0.0412 | 0.0594 | 0.0702 | 0.1093 | 0.2207 |
| » 2.8 » . | 0.1327 | 0.1917 | 0.2737 | 0.4241 | 0.6791 | 1.433 |

The Ferrous salt of naphthalene β mono sulfonate crystallized with 6 $H_2O$. The solubility results are in terms of the anhydrous compound. The solubility curve for α naphthylamine salt of naphthalene β sulfonate shows a break at 54°, and that for the α naphthylamine salt of naphthalene α sulfonate shows a break at 66°.

## NAPHTALENE SULFONIC ACIDS.

### Solubility of Benzyl Pseudo Thiourea Salts of Naphthalene Mono and Disulfonic Acids, in 0.2 Normal Hydrochloric Acid.

(Chambers and Scherer, 1924.)

The experiments were made to obtain data upon which methods for the analytical separation of naphthalene sulfonic acids might be based.

Gms. compound per liter of sat. sol. in 0.2 *n*. HCl.

| | Benzyl pseudo thio urea salt of Naphthalene : | | | | |
|---|---|---|---|---|---|
| t°. | α monosulfonate. | β monosulfonate. | 1.5 disulfonate. | 2.7 disulfonate. | 2.6 disulfonate. |
| 0..... | 4.4 | 0.2 | 0.03 | 0.7 | 0.7 |
| 10..... | 5.8 | 0.3 | 0.07 | 1.2 | 1.1 |
| 20..... | 7.7 | 0.5 | 0.16 | 2.2 | 1.6 |
| 30..... | 10.1 | 0.8 | 0.35 | 3.9 | 2.4 |
| 40..... | 13.5 | 1.2 | 0.77 | 6.6 | 3.7 |
| 50..... | 17.8 | 2.2 | 1.7 | 11.5 | 5.7 |
| 60..... | 23.5 | 3.5 | 3.6 | 20.0 | 8.8 |
| 70..... | 30.9 | 5.5 | 7.8 | 34.7 | 13.8 |
| 80..... | 40.4 | 8.6 | 16.8 | 59.4 | 20.4 |
| 90..... | 54.0 | 13.7 | 35.7 | 103.5 | 31.0 |
| 100..... | 70.0 | 21.6 | 77.6 | 177.8 | 47.3 |

### PIPERONYL ACRYLIC ACID $C_{10}H_8O_4$.

One liter sat. solution in water contains 0.027 gm. piperonyl acrylic acid at 25°, One liter sat. solution of allo piperonyl acrylic acid contains 0.48 gm. at 25°. (Roth and Stoermer, 1913.)

### β NAPHTHYLAMINE $C_{10}H_7.NH_2$.

100 gms. para cymene (b. pt. 176-176.5°) dissolve 8.63 gms. β $C_{10}H_7NH_2$ at 30°.

(Wheeler, 1920.)

### α NAPHTHYLAMINE *p* Sulfonic Acid, 1.4 α $C_{10}H_6NH_2.SO_3H$.

### α NAPHTHYLAMINE *o* Sulfonic Acid, 1.2 α $C_{10}H_6NH_2.SO_3H$.

Solubility of Each Separately in Water.

(Dolinski, 1905.)

| t°. | Gms. per 100 Gms. $H_2O$. *p* Sulphonic Ac. | *o* Sulphonic Ac. | t°. | Gms. per 100 Gms. $H_2O$. *p* Sulphonic Ac. | *o* Sulphonic Ac. |
|---|---|---|---|---|---|
| 0 | 0.027 | 0.24 | 50 | 0.059 | 0.81 |
| 10 | 0.029 | 0.32 | 60 | 0.075 | 1.01 |
| 20 | 0.031 | 0.41 | 70 | 0.097 | 1 37 |
| 30 | 0.037 | 0.52 | 80 | 0.130 | 1.80 |
| 40 | 0.048 | 0.65 | 90 | 0.175 | 2.40 |
| | | | 100 | 0.228 | 3.19 |

The coefficient of distribution of β naphthylamine between benzene and water at 25° is; conc. in $C_6H_6$ ÷ conc. in $H_2O$ = 279. The coefficient for α naphthylamine, similarly determined, is 252.

(Farmer and Warth, 1904.)

Results for equilibrium in the ternary system α Naphthylamine + Resorcinol + Sulfur are given by Hrynakowski, Staszewski and Szmyt, 1937.

Freezing-point data are given for mixtures of Naphthylamines and:

Acetanilide(6)
Acetyl diphenyl(28)
Antipyrine(4)(27)
Acetic acid(21)
Amino phenols(16)
Anthracene(39)(37)
Azobenzene(28)
Benzoic acid(1)(21)(25)
Benzamide(35)
Benzo phenone(19)
Benzo hydrol(13)
Catechol(32)
Camphor(8)
Cinnamic acid(21)
Chloro nitro benzene(2)
Chloro dinitro benzene(2)
Chloro naphthalene(10)(3)
Di anisal acetone(29)
Di nitro benzene(35)(15)
Di phenyl(40)
Di nitro toluenes(17)(15)
Di nitro phenol(15)
Di nitro anisole(5)
Di oxy naphthalenes(18)
Di phenyl methane(14)
Di phenyl amine(37)
Fluorene(26)
Fluorenone(29)
Guaiacol(38)(34)
Hydroquinone(32)(12)
Iodo biphenyl(30)
Methoxy anthraquinone(28)
Methyl naphthalene(3)
Michlers Ketone(26)
Naphthalene(36)(37)(25)
Naphthols(37)(7)(3)(35)(36)(20)
Naphthylamines(4a)
Nitroso dimethyl aniline (35)(23)
Nitro phenols(15)
Nitronaphthalene(41)
Nitro benzene + Quinone(22)
Phenol(11)(33)
Propionic acid(21)
Pyrocatechol(12)
Pyrogallol(24)
Quinone(22)
" + nitro benzene(22)
Resorcinol(32)(37)(12)
Sarcosine anhydride(31)
Salicylic acid(21)(25)
Succinic acid(21)
Tetra methyl di amino benzal acetone(29)
Tetra methyl diamino benzo phenone(29)
Toluidine(37)
Tri chlor acetic acid(9)
Tri nitro benzene(15)(35)(36)
Tri phenyl carbinol(23)
Tri phenyl methane(19)

(1) Baskow, 1918; (2) Giua, Marcellino and Carti, 1920; (3) Grimm, Gunther and Titus, 1931; (4) Hammick, Edwards, Illingworth and Snell, 1933; (4a) Grubelmann and Weiland, 1929; (5) Hertel and Römer, 1930; (6) Hrynakowski and Adamanis, 1933a; (7) Hrynakowski and Szmyt, 1934; (8) Journiaux, 1912; (9) Kitran, 1924; (10) Klemm, Klemm and Schiemann, 1933; (11) Kremann, 1906; (12) Kremann and Csanyi, 1916; (13) Kremann and Drazil, 1924; (14) Kremann and Fritsch, 1920; (15) Kremann and Grasser, 1916; (16) Kremann and Hohl, 1920; (17) Kremann, Hönigsberg and Mauermann, 1923; (18) Kremann, Hemmelmayr, and Riemer, 1922; (19) Kremann and Schadinger, 1918; (20) Kremann and Strochschneider, 1918; (21) Kremann, Weber and Zechner, 1925; (22) Kremann, Sutter, Sitte, Strzelba and Dobotzky, 1922; (23) Kremann and Wlk, 1919; (24) Kremann and Zechner, 1918; (25) Milone and Rossignoli, 1932; (26) Pfeiffer, 1924; (27) Pfeiffer and Angern, 1926; (28) Pfeiffer, Angern, Wang, Seydel and Quehl, 1930; (29) Pfeiffer, Goebel and Angern, 1925; (30) Pfeiffer, Schmitz and Inoue, 1929; (31) Pfeiffer, Angern and Wang, 1927; (32) Philip and Smith, 1905; (33) Philip, 1903; (34) Puschin and Masarowitsch, 1914; (35) Rheinboldt, Henning and Kirscheisen, 1925; (36) Rheinboldt and Kirscheisen, 1926; (37) Vignon, 1891; (38) Puschin and Vaic, 1927; (39) Vignon and Miolati, 1892; (40) Washburn and Read, 1915. (41) Tsakalotos, 1912.

**PHENYL PYRROLE** $C_{10}H_9N$.

100 gms. sat. solution of phenyl pyrrole in liquid sulfur dioxide contain 15 gms. $C_{10}H_9N$ at ? t°. (De Carli, 1927.)

2-Amino-5 **NAPHTHOL-1-SULFONIC ACID** $C_{10}H_3(5)OH(2)NH_2(1)SO_3H$.

1000 cc. cold water dissolve 2.12 gms. of the compound. The solubility of the potassium salt of the compound is about 94 grams per liter at 18°.

(Bucherer and Wahl, 1921.)

**NAPHTHYLAMINE Di SULFONIC ACIDS** 2.6.8 and 2.5.7 $C_{10}H_5(NH_2)(SO_3H)_2$.

100 gms. sat. sol. of the 2.6.8 compound in water contain 9.24 gms. at 15°
» » 2.5.7 » » 22.97 »

(Braunschweig, 1926.)

1- **NAPHTHYLAMINE, 2.4.7-Tri SULFONIC ACID** $C_{10}H_4NH(SO_3H)_3$.

One liter sat. solution of 1 Naphthylamine, 2.4.7-Tri Sulfonic Acid in Water contain 184 gms. $C_{10}H_4NH(SO_3H)_3$ at 20° and 315 gms. at 80°. (Fritsch, 1930.) The author also gives results for the solubility of the Na, Ca, Ba and K salts of this acid in water at 20° and at 80°.

$\left.\begin{matrix}\alpha\\ \beta\end{matrix}\right\}$ **NAPHTHYLAMINE HELIANTHATE** $C_{10}H_7NH_2.C_{14}H_{15}N_3SO_3$.

1000 cc. water dissolve 0.132 gm. of the α compound at 20-25° } (Stark and Dehn, 1918.)
» » 0.103 » β » » }

**PHENYL TARTRIMIDE** and Related Compounds.

Solubility of Each Separately in Water and in Methyl Alcohol.
(Casale, 1917, 1918.)

| Compound. | Formula. | Solvent. | t°. | Gms. cmpd. per 100 gms. sat. sol. |
|---|---|---|---|---|
| *d* Phenyl tartrimide or Tartranil..... | $CHOH.CO\diagdown\diagup NC_6H_5$ / $CHOH.CO$ | $H_2O$ | Changes to tartranilic acid | |
| | | $CH_3OH$ | 18 | 2.84 |
| *d* Phenyl tartraminic acid or Tartranilic acid..... | $CHOH.CONH.C_6H_5$ / $CHOH.COOH$ | $H_2O$ | 17.4 | 2.853 |
| | | $CH_3OH$ | 14 | 15.66 |
| *d* Mono phenyl tartramide or tartranilamide. | $CHOH.CONH.C_6H_5$ / $CHOH.COONH_2$ | $H_2O$ | 21.5 | 0.4726 |
| | | $CH_3OH$ | 21.5 | 1.031 |
| *d* Tartranilide..... | $CHOH.CONH.C_6H_5$ / $CHOH.CONH.C_6H_5$ | $CH_3OH$ | 20 | 0.2151 |
| *p* Ethoxy phenyl tartramide..... | $CHOH.CO\diagdown\diagup NC_6H_4.OC_2H_5$ / $CHOH.CO$ | $CH_3OH$ | 14 | 1.504 |
| *p* Ethoxy phenyl tartraminic acid..... | $CHOH.CONH.C_6H_4.OC_2H_5$ / $CHOH.COOH$ | $H_2O$ | 14 | 0.4005 |
| Methyl ether of *p* Ethoxy phenyl tartraminic acid. | $CHOH.CONH.C_6H_4.OC_2H_5$ / $CHOH.COO.CH_3$ | $CH_3OH$ | 15 | 1.88 |
| Ethyl ether of *p* Ethoxy phenyl tartraminic acid. | $CHOH.CONH.C_6H_4.OC_2H_5$ / $CHOH.COO.C_2H_5$ | $CH_3OH$ | 15 | 4.496 |
| *p* Oxy phenyl tartramide..... | $CHOH.CO\diagdown\diagup N.C_6H_4OH$ / $CHOH.CO$ | $CH_3OH$ | 13 | 2.913 |
| *d* Mono oxy phenyl tartramide..... | $CHOH.CO.NH.C_6H_4OH$ / $CHOH.CO.NH_2$ | $CH_3OH$ | 15 | 1.58 |
| *d* Mono oxy di phenyl tartramide..... | $CHOH.CO.NH.C_6H_4OH$ / $CHOH.CO.NH.C_6H_5$ | $CH_3OH$ | 15 | 1.589 |
| *p* Oxy phenyl tartraminic acid..... | $CHOH.CO.NH.C_6H_4OH$ / $CHOH.COOH$ | $H_2O$ | 14 | 4.215 |

**PYRENE** $C_{10}H_{10}$.

Freezing-point data are given by Shinomiya, 1940, for mixtures of Pyrene and each of the following compounds: Dinitro benzenes, dinitro phenol, dinitro toluene, picramide, picryl chloride, tetra nitro benzene tri nitro anisole, tri nitro benzene, tri nitro cresol, and tri nitro toluene

**DIHYDRO NAPHTHALENE** $C_{10}H_{10}$.

Freezing-point data for mixtures of dihydro naphthalene and naphthalene are given by Küster, 1891.

**NAPHTHYLENE DIAMINE** $C_{10}H_6(NH_2)_2$.

Freezing-point data for mixtures of naphthalene diamine and o cresol are given by Puschin and Sladovic, 1928.

**BENZAL ACETONE** $C_6H_5CH:CHCOCH_3$.

Freezing-point data are given by Pfeiffer, Goebel, and Angern, 1925, for mixtures of Benzal acetone and each of the following compounds: Acenaphthene, Naphthylamine, Nerolin, Nitraniline and Tetra methyl diamino dibenzal acetone.

**BENZOYL ACETONE** $C_6H_5COCH_2COCH_3$.

100 gms. sat. solution of benzoyl acetone in liquid sulfur dioxide contain about 43 gms. $C_6H_5COCH_2COCH_3$ at ? t°. (DeCarli, 1927.)

**METHYL CINNAMIC ACID** $C_6H_5C(CH_3):CHCOOH$.

SOLUBILITY OF SEVERAL ALKYL CINNAMIC ACIDS IN BENZENE AND IN PETROLEUM ETHER. (Stoermer, Grimm and Laage, 1917.)

| Compound. | Formula. | M. pt. | t°. | Gms. cmpd. per 100 gms. Benzene. | Petroleum ether. |
|---|---|---|---|---|---|
| β Methyl cinnamic acid (stable) | $C_6H_5.C(CH_3):CH.COOH$ | 98.5 | 21 | 19.2 | 2.08 |
| " " (unstable) | " | 131.5 | 21 | 7.8 | 0.89 |
| " " (mixed form) | " | 76.0 | 21 | 12.2 | 5.2 |
| β Ethyl cinnamic acid (stable) | $C_6H_5.C(C_2H_5):CH.COOH$ | 95.5 | 20 | 11.5 | 1.7 |
| " " (unstable) | " | 93.5 | 20 | 21.5 | 0.68 |
| " " (mixed) | " | 62-63 | 20 | 122.0 | 6.2 |
| β Propyl cinnamic acid (stable) | $C_6H_5.C(C_3H_7):CH.COOH$ | 94 | 18 | 14.6 | 1.5 |
| " " (unstable) | " | 86.5 | 22 | 58.0 | 4.5 (18°) |
| " " (mixed) | " | 59-60 | 23 | 88.5 | 9.8 (21°) |
| o Methoxy β Methyl cinnamic acid (stable) | $(2)CH_3O.C_6H_4.C(CH_3):CHCOOH$ | 96.5 | 21 | 10.0 | 1.1 |
| " " (unstable) | " | 123.4 | 21 | 8.2 | 0.1 |
| " " (mixed) | " | 76-78 | 21 | 33.2 | 2.25 |
| p β Dimethyl cinnamic acid (stable) | $CH_3(3)C_6H_4C(CH_3):CHCOOH$ | 135 | 20 | 2.6 | 0.12 |
| " " (unstable) | " | 117.5-118 | 20 | 11.8 | 0.55 |
| " " (mixed) | " | 94-96 | 20 | 18.2 | 1.8 |

**METHYL CINNAMATE** $C_6H_5CH:CHCOOCH_3$.

The critical solution temperature of mixtures of methyl cinnamate and iso amyl benzoate is 15.8°. (Lecat, 1928.)

Freezing-point data for mixtures of methyl cinnamate with chloro acetic acid and tri chloro acetic acid are given by Kendall and Booge, 1916.

**METHYL PHENYL TRICHLORO ETHYL CARBAMATE** $CO(NCH_3.C_6H_5)(OC_2H_2Cl_3)$.

Freezing-point data for mixtures of n Methyl phenyl voluntal with acetyl amino antipyrine, with antipyrine and with sarcosine anhydride are given by Pfeiffer and Seydel, 1928a.

**METHOXY CINNAMIC ACID** p $CH_3O.C_6H_4CH:CHCOOH$.

One liter sat. solution of p methoxy cinnamic acid in water contains 0.0712 gm. $CH_3O.C_6H_4CH:CHCOOH$ at 25°.
One liter sat. solution of allo p methoxy cinnamic acid in water contains 1.966 gms. at 25°. (Roth and Stoermer, 1913.)

Freezing-point data are given for:

p Methoxy Cinnamic acid + Azoxyphenetol (Prins, 1909.)
" " " + p Azoxyanisole (de Kock, 1904.)
" " " + Hydroquinone " "

p **METHOXY PHENYL FUROXIME** $CH_3OC_6H_4[(C_2N_2O)O]CH_3$.

Freezing-point data for mixtures of p methoxy phenyl furoxime and methoxy phenyl methyl dioxy diazine are given by Milone, 1929.

**METHYL CUMARIC ACID** $C_{10}H_{10}O_3$.

One liter sat. solution in water contains 0.084 gm. methylcumaric acid at 25°. (Roth and Stoermer, 1913.)

**METHYL CUMARINIC ACID** $C_{10}H_{10}O_3$.

One liter sat. solution in water contains 0.712 gms. methyl cumarinic acid at 25°. (Roth and Stoermer, 1913.)

**DIMETHYL TEREPHTHALATE** $C_6H_4(COOCH_3)_2$.

Freezing-point data for mixtures of dimethyl terephthalate and tri chloracetic acid are given by Kendall and Booge, 1916.)

**CREATININE PICRATE** $C_4H_7N_3O.OHC_6H_2(NO_2)_3$.

100 gms. sat. solution in water contain 0.122 gm. picrate at 7°.5, 0.182 gm. at 21°, 0.263 gm. at 32.5°, 0.416 gm. at 48.0°, 1.035 gm. at 78° and 1.572 gm at 92°.
100 gms. sat. solution in aq. 50 % ethyl alcohol contain 0.224 gm. picrate at 8°, 0 362 gm. at 19°. 0.753 gm. at 37°, 1.718 gm. at 57° and 3.1 6 gm. at 74°.
(Medes, 1925-1926.)

n-α-DIMETHYL INDOLE $(CH_3)_2NC_8H_5$.

Freezing-point data for mixtures of n-α dimethyl indole and sarcosine anhydride are given by Pfeiffer, Angern and Wang, 1927.

*p* Acetoxy **ACETANILIDE**, $CH_3CO.OC_6H_4NHCOCH_3$ *p*.

100 cc. of sat. solution in water contain 0.239 gms. $CH_3CO.OC_6H_4NHCOCH_3$ at 25°.
100 cc. of sat. solution in chloroform contain 3.25 gms. " "
(Emery and Wright, 1921.)

Data for the distribution of *p* acetoxyacetanilide between water and chloroform are also given by Emery and Wright, 1921.

**ANETHOLE** (*p* Propylanisole) $CH_3CHCH[4]C_6H_4OCH_3$.

SOLUBILITY IN AQUEOUS ALCOHOL AT 20°
(Schimmel and Co., Reports, Oct. 1895, p. 6.)

| Vol. per cent alcohol = | 20 | 25 | 30 | 40 | 50 |
|---|---|---|---|---|---|
| Gm. anethole per liter aq. alcohol = | 0.12 | 0.20 | 0.32 | 0.86 | 2.30 |

333.3 gms. anethole dissolve in one liter of 90% alcohol at room temperature.
(Squire and Caines, 1905)

Freezing-point data for mixtures of anethole and menthol are given by Scheuer (1910).

**CUMINIC ACID** $C_3H_7C_6H_4.COOH$ (*p* Isopropyl Benzoic Acid).

SOLUBILITY IN WATER AT 25°. (Paul, 1894.)

1000 cc. sat. solution contain 0.1519 gm. or 0.926 millimol cuminic acid.

**TETRALIN** (1, 2, 3, 4-Tetrahydro Naphthalene) $C_{10}H_{12}$.

SOLUBILITY OF TETRALIN IN SUPER-HEATED WATER. (Jaeger, 1926)

The determinations were made in a large shaking autoclave. The air in the autoclave was previously displaced and mixtures of 500 cc. of the hydrocarbon and 2 liters of water were introduced and shaken 10 minutes at each temperature and allowed to stand 20 minutes. 500 cc. of the solution were withdrawn and after allowing about a day for the separation of the two layers the volume of the upper floating layer was carefully measured.

| t°..... | 150°. | 200°. | 250°. |
|---|---|---|---|
| Cc. $C_{10}H_{10}$ dissolved per 100 cc. $H_2O$. | 0.02 (0.02) | 0.04 (0.04-0.09) | 0.40 (0.35-0.90) |

Experiments made with various samples of hydrocarbons from generator tar, gas flame coal tar, etc., gave results (shown in parentheses) agreeing quite closely with those for tetralin.

## ALLYL PHENYL THIO UREA $(NHC_3H_5)(NHC_6H_5)CS$.

### Solubility of Allyl Phenyl Thiourea in Several Solvents.

(Schischokin, 1928.)

Results for:

| Acetic Acid | | Methyl Alcohol | | Ethyl Alcohol | | Paraldehyde | |
|---|---|---|---|---|---|---|---|
| t° | Gm. Mols. $C_{10}H_{12}N_2S$ per 100 gm. mols. sat. sol. | t° | Gm. Mols. $C_{10}H_{12}N_2S$ per 100 gm. mols. sat. sol. | t° | Gm. Mols. $C_{10}H_{12}N_2S$ per 100 gm. mols. sat. sol. | t° | Gm. Mols. $C_{10}H_{12}N_2S$ per 100 gm. mols. sat. sol. |
| 43.0 | 5.02 | 40.0 | 4.57 | 44.7 | 4.85 | 49.0 | 4.92 |
| 56.5 | 10.50 | 46.0 | 6.99 | 55.2 | 10.18 | 58.0 | 9.71 |
| 65.5 | 19.89 | 59.5 | 19.24 | 61.3 | 16.55 | 68.0 | 19.42 |
| 72.5 | 31.04 | 65.7 | 28.13 | 64.8 | 21.44 | 72.8 | 27.23 |
| 76.7 | 41.16 | 71.7 | 38.37 | 68.8 | 26.63 | 78.3 | 40.37 |
| 78.1 | 49.54 | 77.2 | 48.70 | 70.2 | 31.49 | 81.2 | 48.98 |
| 84.8 | 63.57 | 81.5 | 57.63 | 74.5 | 41.16 | 84.5 | 59.54 |
| 86.7 | 67.83 | 86.5 | 70.79 | 78.7 | 49.54 | 88.6 | 70.58 |
| 91.0 | 78.74 | 91.0 | 77.45 | 84.8 | 63.57 | 92.3 | 80.0 |
| 99.0 | 100.00 | 99.0 | 100.00 | 91.0 | 78.74 | 99.0 | 100.0 |

| Chloroform | | | | Tri chlor acetic acid | | Acetic acid anhydride | |
|---|---|---|---|---|---|---|---|
| t° | Gm.Gm. Mols. $C_{10}H_{12}N_2S$ per 100 gms. mols. sat. sol. | t° | Gm. Mols. $C_{10}H_{12}N_2S$ per 100 gms. mols. sat. sol. | t° | Gm. Mols. $C_{10}H_{12}N_2S$ per 100 gm. mols. sat. sol. | t° | Gm. Mols. $C_{10}H_{12}N_2S$ per 100 gm. mols. sat. sol. |
| 46.7 | 19.85 | 85.0 | 62.76 | < 50 | 44.69 | 43.5 | 54.04 |
| 58.0 | 28.56 | 86.0 | 67.26 | 69 | 58.81 | 71.3 | 66.63 |
| 66.5 | 36.86 | 90.8 | 78.36 | 74.5 | 68.66 | 81.3 | 78.46 |
| 75.0 | 47.46 | 99.1 | 100.0 | 81.8 | 75.57 | 99.0 | 100.00 |

| Di bromo benzene | | o Nitraniline | | Nitro benzene | | Di phenyl amine | |
|---|---|---|---|---|---|---|---|
| t° | Gm. Mols. $C_{10}H_{12}N_2S$ per 100 gm. mols. sat. sol. | t° | Gm. Mols. $C_{10}H_{12}N_2S$ per 100 gm. mols. sat. sol. | t° | Gm. Mols. $C_{10}H_{12}N_2S$ per 100 gm. mols. sat. sol. | t° | Gm. Mols. $C_{10}H_{12}N_2S$ per 100 gm. mols. sat. sol. |
| 87 | 0.0 (1) | 71.0 | 0.0 (2) | 30.0 | 4.98 | 53.8 | 19.50 |
| 83.7 | 11.0 (1) | 65.5 | 9.90(2) | 42.5 | 9.92 | 57.0 | 21.60 |
| 81.5 | 20.45(1) | 63.2 | 13.20(2) | 56.2 | 19.26 | 64.6 | 30.30 |
| 79.2 | 30.20(1) | 59.0 | 19.94(2) | 65.3 | 29.85 | 69.0 | 34.70 |
| 79.0 | 41.68 | 60.5 | 29.46 | 72.5 | 39.60 | 72.5 | 39.62 |
| 81.0 | 47.30 | 70.5 | 41.99 | 80.0 | 52.86 | 77.5 | 48.80 |
| 85.0 | 60.47 | 83.0 | 62.28 | 83.9 | 61.01 | 78.0 | 49.32 |
| 88.2 | 70.33 | 91.5 | 80.50 | 90.5 | 76.25 | 83.5 | 60.00 |
| 92.3 | 82.12 | 99.0 | 100.0 | 94.3 | 88.10 | 88.5 | 70.77 |
| 95.8 | 90.91 | | | | | 91.5 | 78.40 |

(1) Solid Phase, Di bromo benzene (2) Solid Phase, o Nitraniline.

Freezing-point data are given by Schischokin, 1930, for ternary mixtures containing allyl phenyl thiourea, allyl mustard oil, acetanilide, aniline and toluidines.

**THYMOQUINONE** $(CH_3)_2CHC_6H_2CH_3O_2$.

Freezing-point data are given for mixtures of thymoquinone and cinnamylidine acetophenone. (Giua, 1925.)

**ISO EUGENOL** $CH_3CH{:}CHC_6H_3(OCH_3)OH$.

**ISO CHAVIBETOL** $CH_2{:}CHCH_2C_6H_3(OH)(OCH_3)$.

Freezing-point data for mixtures of iso eugenol and iso chavibetol are are given by Hiraidzumi, 1932.

**ETHYL MANDELATES** $C_6H_5CH(OH)COOC_2H_5$.

Freezing-point data for mixtures of the optical isomerides of ethyl mandelate are given by Ross, 1936.

**CANTHARIDINE**

Approximate Solubility in Several Solvents at Room Temp.
(Self and Greenish, 1907.)

| Solvent. | Gms. Cantharidine per 100 Gms. Solvent. | Solvent. | Gms. Cantharidine per 100 Gms. Solvent. |
|---|---|---|---|
| Aq. 25% Acetone | 0.02 | Aq. 10% Acetic Acid | 0.14 |
| " 50% " | 0.16 | " 45% Formic " | 0.12 |
| " 75% " | 0.45 | Carbon Tetrachloride | 0.04 |
| | | Lanolin | 4.4 (Klose, 1907.) |

**TRI NITRO DI ETHYL ANILINE** $2.4.6,(NO_2)_3C_6H_2N(C_2H_5)_2$.

100 gms. $H_2O$ dissolve 0.005 gm. $C_{10}H_{12}O_6N_4$ at 50° and 0.020 gm. at 100°. (Desvergnes, 1926.)

**DILACTONE** $C_{10}H_{12}O_8$.

Solubility of Dilactone in Water. (Feofilaktow, 1926.)

Dilactone is the product of aldol condensation of two molecules of α Oxo-β-methyl-γ-butyrolactone. The author does not state the exact terms in which the results are given but it is probable that the figures refer to the grams of lactone per 100 gms. of water.

| t°..... | 0°. | 25°. | 50°. | 75°. | 100°. |
|---|---|---|---|---|---|
| Gms. lactone per 100 gms. $H_2O$..... | 2.5 | 5.2 | 18.4 | 87.4 | 176.0 |

**PHENACETIN** (*p* Acetophenetide) $C_6H_4(OC_2H_5)NHCH_3CO$ *p*.

Solubility of Phenacetin in Several Solvents.

| Solvent. | t°. | Gms. $C_6H_4(OC_2H_5)NHCH_3CO$ *p* per 100 gms. solvent. | Authority. |
|---|---|---|---|
| Walter..... | 14° | 0.054 | (Oliveri-Mandala, 1926.) |
| Aq. 9.984% Antipyrine solution..... | 14° | 0.128 | " |
| Absolute Alcohol (*com.*)..... | 20–25° | 18.80 | (Pucher and Dehn, 1926.) |
| Quinoline..... | " | 7.83 | " |
| Equi mol mixture Alcohol and quinoline. | " | 12.87 | " |

### Solubility of Phenacetin in Aqueous Alcohol at 25°.

(Seidell, unpublished)

| Wt. % $C_2H_5OH$ in Solvent. | $d_{25}$ of Sat. Sol. | Gms. $C_6H_4(OC_2H_5)NHCH_3CO$ per 100 Gms. Sat. Solution. | Wt. % $C_2H_5OH$ in Solvent. | $d_{25}$ of Sat. Sol. | Gms. $C_6H_4(OC_2H_5)NHCH_3CO$ per 100 Gms. Sat. Solution. |
|---|---|---|---|---|---|
| 0 (water) | 1 | 0.0766 | 70 | 0.879 | 6.25 |
| 10 | 0.984 | 0.14 | 80 | 0.858 | 7.63 |
| 20 | 0.968 | 0.28 | 85 | 0.847 | 7.88 |
| 30 | 0.952 | 0.65 | 90 | 0.834 | 7.82 |
| 40 | 0.935 | 1.50 | 92.3 | 0.827 | 7.70 |
| 50 | 0.917 | 2.85 | 95 | 0.821 | 7.45 |
| 60 | 0.898 | 4.55 | 100 | 0.806 | 6.64 |

100 gms. $H_2O$ dissolve 1.43 gms. phenacetin at the b. pt. (U.S.P., VIII.)
100 gms. 92.3 wt. % alcohol dissolve about 50 gms. phenacetin at the b. pt. "

100 gms. Ethyl ether (abs.) dissolve 0.31–0.33 gm. phenacetin at 25°.
100 gms. Ethyl ether containing 3.6% $C_2H_5OH$ dissolve 0.64–0.98 gm. phenacetin at 25°.
100 gms. Ethyl ether containing less than 3.0% $C_2H_5OH$ dissolve 0.525 gm. phenacetin at 25°. (Taylor and Bebie, 1924.)
100 gms. $CCl_4$ dissolve 0.037 gm. phenacetin at 25°. (Warren, 1933.)

### Solubility of Phenacetin in Several Solvents.

(Seidell, 1907.)

| Solvent. | t°. | Gms. Phenacetin per 100 Gms. Sat. Solution. | Solvent. | t°. | Gms. Phenacetin per 100 Gms. Sat. Solution. |
|---|---|---|---|---|---|
| Acetone | 30–31 | 10.68 | Benzene | 30–31 | 0.65 (0.873) |
| Amyl Acetate | 30–31 | 2.42 (0.865) | Chloroform | 25 | 4.76 |
| Amyl Alcohol | 25 | 3.51 (0.819) | Ether | 25 | 1.56 |
| Acetic Acid (99.5%) | 21.5 | 13.65 (1.064) | Toluene | 25 | 0.30 (0.863) |
| Aniline | 30–31 | 9.46 (1.025) | Xylene | 32.5 | 1.25 (0.847) |
| Benzaldehyde | 30–31 | 8.44 (1.063) | | | |

(Figures in parentheses are Sp. Gr. of Sat. Solutions.)

100 cc. petroleum ether dissolve 0.015 gm. phenacetin at room temp. (Salkower, 1916.)
100 gms. pyridine dissolve 17.39 gms. phenacetin at 20–25°. (Dehn, 1917.)
100 gms. aq. 50% pyridine dissolve 28.94 gms. phenacetin at 20–25°. "

Freezing-point data are given for mixtures of Phenacetin and:

Acetanilide(1)(2)(3)(5)
Antipyrine(2)(3)(8)
Benzoic acid(5)
Bromural(4)(6)
Menthol(2)(3)
Pyramidon(1)
Quinine(2)(8)(3)
Resorcinol(2)
Salol(2)(3)(7)(8)
Sulfonal(2)(3)
Thymol(7)
Urea(2)(3)(8)
Urethan(2)(3)(5)(8)
Veronal(4)

Results for ternary mixtures of phenacetine, acetanilide, antipyrine, menthol, quinine, resorcinol, sulfonal, urea and urethan(2)

(1) Angelletti, 1927; (2) Hrynakowski, 1934; (3) Hrynakowski and Adamanis, 1933, 1933a; (4) Hrynakowski and Szmyt, 1935d; (5) Kitran, 1924; (6) Sandquist and Höle, 1927; (7) Quercigh and Cavagnari, 1912; (8) Adamanis, 1933.

**CYMENE** $C_6H_3(CH_3)(C_3H_7)$.

F. pt. data for mixtures of cymene and $SO_2$ are given by De Carli, 1926

**TETRA METHYL BENZENES** (Durene and Iso durene) $C_6H_2(CH_3)_4$.

Freezing-point data for mixtures of durene and isodurene are given by Smith and Mac Dougall, 1929.

**NICOTINE** $C_{10}H_{14}N_2$.

SOLUBILITY IN WATER.

(Hudson, 1904.)

Determinations made by Synthetic Method, for which see Note, page 16. Below 60° and above 210° both liquids are miscible in all proportions; likewise with percentages of nicotine less than 6.8 and above 82 per cent the liquid does not show two layers at any temperature. Below 94° the upper layer is water. Above 94° the upper layer is nicotine. The curve plotted from the following results makes a complete circle.

| Percentage of Nicotine in the Mixture. | Temperature of Appearance of Two Layers. Degrees C. | Temperature of Homogeneity. Degrees C. |
|---|---|---|
| 6.8 | 94 | 95 |
| 7.8 | 89 | 155 |
| 10.0 | 75 | ... |
| 14.8 | 65 | 200 |
| 32.2 | 61 | 210 |
| 49.0 | 64 | 205 |
| 66.8 | 72 | 190 |
| 80.2 | 87 | 170 |
| 82.0 | 129 | 130 |

Additional data for the above system are given by Tsakalotos (1909). The values for the temperatures of saturation are in general, from 1° to 5° lower than those of Hudson.

The temperature of clouding of various mixtures of nicotine and aqueous solutions of sodium hydroxide, sodium sulfate and hydrochloric acid was determined by Dubrisay, 1922. The results were used in the study of certain reactions. When plotted, a change in direction of the curve was found to occur at the point of neutralization. The presence of acids, bases and salts was shown to modify considerably the miscibility of liquid pairs.

The formation of hydrates of nicotine and their decomposition at higher temperatures is suggested by Jephcott, 1919, as the explanation of the true nature of the « closed curve of solubility. »

Results for the effect of various salts and organic acids upon the inter facial tension by the drop method and the critical mixing temperature (60.9°) of nicotine and water are given by Ssementschenko and Davidoffskaja, 1934. Results for the effect of deuterium upon the lower critical solution temperature of nicotine-water mixtures are given by Hall, Wentzel and Smith, 1934.

Results in the form of curves, showing the decreasing solubility of nicotine in water caused by increasing amounts of various salts at 50°, and the effect of increasing amounts of $(NH_4)_2SO_4$ at temperatures between 30 and 80°, are given by Cuvelier, 1936.

## NICOTINE SILICO TUNGSTATE $2C_{10}H_{14}N_2.SiO_2.12WO_3.2H_2O$.

### Solubility of Nicotine Silicotungstate in Aqueous Hydrochloric Acid at 25°.

(Spies, 1936.)

The saturated solutions were prepared by constant stirring and approaching equilibrium both from above and from below. The saturated solutions were analyzed by evaporating in a platinum dish and igniting the residue.

| Normality of Aq. HCl solvent | Gms. $2C_{10}H_{14}N_2.SiO_2.12WO_3.2H_2O$ per liter sat. solution | Normality of Aq. HCl solvent | Gms. $2C_{10}H_{14}N_2.SiO_2.12WO_3.2H_2O$ per liter sat. solution |
|---|---|---|---|
| 0.0 (= $H_2O$) | 0.0385 (pH = 6.5) | 0.025 | 0.00759 |
| 0.001 | 0.00608 | 0.030 | 0.00780 |
| 0.005 | 0.00530 | 0.050 | 0.00941 |
| 0.010 | 0.00556 | 0.070 | 0.01100 |
| 0.015 | 0.00696 | 0.100 | 0.01340 |
| .020 | 0.00681 | | |

## THYMOL (3 Methyl 6 Isopropyl Phenol) $C_3H_7.C_6H_3.OH.CH_3$.

### Solubility in Water. (Seidell, 1912.)

| t°. | Gms. Thymol per 100 Gms. Sat. Sol. | t°. | Gms. Thymol per 100 Gms. Sat. Sol. | t°. | Gms. Thymol per 100 Gms. Sat. Sol. |
|---|---|---|---|---|---|
| 10 | 0.067 | 25 | 0.0995 | 37 | 0.132 ($d_{37}=1$) |
| 15 | 0.077 | 30 | 0.112 | 40 | 0.141 |
| 20 | 0.088 | 35 | 0.126 | | |

### Solubility of Thymol in Water.

By means of a stalogmometric method (see Carvone, p. 676 ) the solubility of thymol in water was found by Rhode, 1922, to be 5.7 millimols, or 0.876 gms., per liter at 15-20°.

Approximate determinations of the solubility of thymol in water made by analysis of the saturated solution (temperature of saturation not stated) and by measuring its freezing-point gave, respectively, 0.78 and 1.11 gm. thymol per liter.

(Vladesco, 1922.

### Reciprocal Solubility of Thymol and Water.

(Wilcox and Bailey, 1929.)

The determinations were made partly by thermal analysis and partly (for co-existing liquids) by the synthetic method.

| t° | Gms. $C_{10}H_{13}OH$ per 100 gms. sat. sol. | | Solid Phase |
|---|---|---|---|
| | $H_2O$ rich layer | Thymol rich layer | |
| 0.0 | 0 | — | Ice |
| -0.05 (Eutec) | 0.04 | — | " + $C_{10}H_{13}OH$ |
| +15.0 | — | 95.6 | Liquid layers |
| 40.0 | 0.1 | 95.4 | " " |
| 65 | 0.1 | 95.0 | Liquid layers |
| 120 | 0.1+ | 90.0 | " " |
| 200 | 10.0 | 75.1 | " " |
| 250 | 19.0 | 71.5 | " " |
| 270* | 20.0 | 70.2 | " " |

* It was not possible to observe the critical solution temperature of the system since the vapor-liquid critical temperature was reached before complete miscibility was obtained. The authors also give results for equilibrium in the ternary system thymol, phenol and water. (See p. 385 )

$C_{10}H_{14}O_1$



## Solubility of Thymol in Aqueous Hydrochloric Acid. (Seidell, 1912.)

| Normality of Aq. HCl. | Gm. Thymol per 100 cc. Sat. Sol. at: 25°. | 37.2°. |
|---|---|---|
| 0 | 0.0995 | 0.132 |
| 0.1 | 0.0968 ($d_{25}$ = 1.002) | 0.129 |
| 0.5 | 0.0884 ($d_{25}$ = 1.009) | 0.121 |
| 1 | 0.0802 ($d_{25}$ = 1.018) | 0.112 |
| 2.5 | 0.0612 ($d_{25}$ = 1.043) | 0.0935 |
| 5 | 0.0445 | 0.0772 ($d_{25}$ = 1.081) |

100 cc. 90 vol. per cent alcohol dissolve about 300 gms. of thymol at 15°-20°. (Squire and Caines, 1905.)

100 gms. aq. 0.4 normal sodium oleate solution (= 10.8 gm. Na Oleate per 100 gms. solution) dissolve 6.3 gms. $C_{10}H_{13}OH$ at 45°. (Smith, 1932.)

## Solubility of Thymol in Aqueous Solutions of Glycerol at 25°.

(Marquina, 1917.)

The saturated solutions were analyzed by the Messinger and Vortmann method as modified by Redman, Werth and Brock.

| Wt. per cent Glycerol In solvent. | Gms. Thymol per 100 gms. sat. sol | Wt. per cent Glycerol in solvent | Gms. Thymol per 100 gms. sat. sol. |
|---|---|---|---|
| 0.0 (= water) | 0.0952 | 75.10 | 0.433 |
| 20.01 | 0.114 | 85.15 | 0.695 |
| 24.95 | 0.126 | 100.00 | 1.71 |
| 50.19 | 0.193 | | |

100 gms. para cymene (b. pt. 176°-176°.5) dissolve 113.85 gms. thymol at 25°. (Wheeler, 1920.)

## Distribution of Thymol between Water and Oils at 25° and at 37°.

(Seidell, 1912.)

| | Water + Olive Oil. | | | Water + Cod Liver Oil. | | | Water + Peanut Oil. | | |
|---|---|---|---|---|---|---|---|---|---|
| t°. | Gms. Thymol per 100 cc. $H_2O$ Layer ($c_w$). | Oil Layer ($c_0$). | $\frac{c_0}{c_w}$. | Gms. Thymol per 100 cc. $H_2O$ Layer ($c_w$). | Oil Layer ($c_0$) | $\frac{c_0}{c_w}$ | Gms. Thymol per 100 cc. $H_2O$ Layer ($c_w$). | Oil Layer ($c_0$). | $\frac{c_0}{c_w}$. |
| 25 | 0.1014 | 44.95 | 443 | 0.1079 | 49 | 454 | 0.1077 | 46.48 | 431 |
| 25 | 0.0848 | 36.34 | 428 | 0.0816 | 32.58 | 400 | 0.0786 | 32.45 | 413 |
| 25 | 0.0349 | 16.26 | 465 | 0.0371 | 16.18 | 436 | 0.0305 | 16.16 | 409 |
| 25 | 0.0106 | 4.54 | 430 | 0.0127 | 4.57 | 359 | 0.0088(?) | 4.63 | 523 |
| 37 | 0.1087 | 46.35 | 427 | 0.1099 | 43.81 | 399 | | | |
| 37 | 0.0807 | 33.48 | 415 | 0.0862 | 32.90 | 380 | | | |
| 37 | 0.0381 | 16.24 | 426 | 0.0574 | 22.51 | 392 | | | |
| 37. | 0.0122 | 4.61 | 378 | 0.0250 | 8.86 | 357 | | | |

$C_{10}H_{14}O_1$

SOLUBILITY OF THYMOL IN SEVERAL OILS. (Seidell, 1912.)

| t°. | Gms. Thymol per 100 Gms. of: Olive Oil. | Peanut Oil. | Cod Liver Oil. | Liquid Petrolatum. | Castor Oil. | Cottonseed Oil. | Linseed Oil. |
|---|---|---|---|---|---|---|---|
| 10 | 46.2 | 73 | 50 | 3.1 | 81.2 | 56.2 | 62.3 |
| 15 | 50.1 | 73.8 | 52 | 3.95 | 90.2 | 64 | 63.1 |
| 20 | 56.2 | 74.6 | 55.5 | 5.6 | 101.5 | 74.2 | 65.1 |
| 25 | 66.9 | 76.4 | 63.1 | 9.78 | 116.5 | 89.4 | 69 |
| 30 | 84.5 | 83.2 | 77 | 16.3 | 137 | 113.7 | 78.3 |
| 35 | 111 | 106.7 | 102 | 25.5 | 165 | 146.5 | 100 |
| 37 | 124.3 | 130.5 | 116.5 | 29.9 | 180 | 166.5 | 116.5 |
| 40 | 151.9 | 212.5 | 150 | 38.9 | 213 | 217.5 | 152 |

The specific gravities of the above saturated solutions and of solutions of lower concentrations of thymol in the several oils are also given.

Freezing-point data are given for mixtures of Thymol and:

Acetanilide(1)(3)(9)
Acetic acid(6)
Antipyrine(3)
Benzo phenone(7)
Bromo toluene(6)
Camphor(3)
Chlor acetic acid(5)
Cineole(12)
Naphthalene(2)(10)
Phenol(3)(6)
Phenacetine(9)
Phenylene diamine(8)
Salicylic acid(3)
Salol(3)
Sulfonal(9)
Sulfuric acid(4)
Tri chlor acetic acid(11)
Urea(3)

(1) Angelitti, 1928; (2) Bernoulli and Veillon, 1932; (3) Hrynakowski and Szmyt, 1935; (4) Kendall and Carpenter, 1914; (5) Mameli and Cocconi 1923; (6) Paterno and Ampola, 1897; (7) Pawlewski, 1893; (8) Puschin and Dezelic, 1938; (9) Quercigh and Cavagnari, 1912; (10) Roloff, 1895; (11) Kendall, 1916; (12) Bellucci and Grassi, 1913.

**CARVACROL** $(CH_3)_2CH.C_6H_3(CH_3)OH$.

MISCIBILITY OF AQ. ALKALINE SOLUTIONS OF CARVACROL WITH SEVERAL ORGANIC COMPOUNDS INSOLUBLE IN WATER. (Scheuble, 1907.)

To 5 cc. portions of aq. KOH solution (250 gms. per liter) were added the given amounts of the aq. insoluble compound from a buret and then the carvacrol, dropwise until solution occurred. Temperature not stated.

| Composition of Homogeneous Solutions. | | |
|---|---|---|
| Aq. KOH. | Aq. Insol. Compd. | Carvacrol. |
| 5 cc. | 2 cc. (= 1.64 gms.) Octyl(1) Alcohol | 1.8 gms. |
| 5 " | 5 cc. (= 4.1 gms.) " | 2.6 " |
| 5 " | 2 cc. (= 1.74 gms.) Toluene | 4 " |
| 5 " | 3 cc. (= 2.61 gms.) " | 4.8 " |
| 5 " | 2 cc. (= 1.36 gms.) Heptane | 4.6 " |

(1) = the normal secondary octyl alcohol, *i.e.*, the so-called capryl alcohol, $CH_3(CH_2)_5.CH(OH)CH_3$.

## CARVONE $C_{10}H_{14}O$, CARVENONE $C_{10}H_{16}O$, etc.

### Solubility of Each Compound Separately in Water at 15-20°.

(Rhode, 1922.)

The determinations were made by a stalogmometric method in which the number of drops per unit of time in the case of saturated solutions and their dilutions were compared with the number of drops per unit of time found for solutions of known content. For obtaining saturation long periods of shaking were often necessary. The attainment of saturation was controlled by stalogmometric measurements.

| Compound. | Formula. | Millimols. per liter of sat. sol. |
|---|---|---|
| Carvone | $CH_2.C\begin{matrix}\diagup CH.CH_2\diagdown\\ \diagdown CO.CH_2\diagup\end{matrix}CH.C(CH_3).CH_3$ | 8.8 |
| Carvenone | $CH_3.CH\begin{matrix}\diagup CO.CH\diagdown\\ \diagdown CH_2.CH_2\diagup\end{matrix}C.CH(CH_3)_2$ | 14.5 |
| Dihydro carvone | $CH_3.CH\begin{matrix}\diagup CO.CH_2\diagdown\\ \diagdown CH_2.CH_2\diagup\end{matrix}CH.C(CH_3)_2.CH_2$ | 6.8 |
| Tetrahydro carvone | $CH_3.CH\begin{matrix}\diagup CO.CH_2\diagdown\\ \diagdown CH_2.CH_2\diagup\end{matrix}CH.CH(CH_3)_2$ | 3.9 |
| Carvotanazetone | $C_{10}H_{16}O$ | 5.8 |

## THYMO HYDROQUINONE $CH_3(C_3H_7)C_6H_2(OH)_2$.

Freezing-point data for mixtures of thymo hydroquinone and cinnamylidene acetophenone are given by Giua, 1925.

## CAMPHORIC ANHYDRIDE $C_{10}H_{14}O_3$ *d* and *l*.

One liter of benzene dissolves 37.5 gms. *d* camphoric anhydride at 5°, determined by depression of the freezing-point. (Sidgwick, 1915.)

## ACETYLENE METHYL TETRA CARBONATE $[CH(COOCH_3)_2]_2$

Freezing-point data for mixtures of acetylene methyl tetra carbonate with methyl succinate, with ethyl succinate and with ethylene cyanide are given by Timmermans and Vesselovsky, 1931.

## DIETHYL ANILINE $C_6H_5N(C_2H_5)_2$.

Freezing-points of mixtures of diethyl aniline, mono ethyl aniline and aniline are given by Yaginuma and Hagakawa, 1932.

**Bromo CAMPHOR** $\alpha$ $C_{10}H_{15}OBr$.

APPROXIMATE SOLUBILITY IN SEVERAL ORGANIC SOLVENTS AT ORDINARY TEMP.
(U. S. P.; Squires; Beilstein; results in alcohol by Müller, 1892)

| Solvent. | Parts Bromo Camphor per 100 Parts Solvent. | Solvent. | Parts Bromo Camphor per 100 Parts Solvent. |
|---|---|---|---|
| Alcohol | 12.1 at 15° | Ether | 50 |
| " | 19.7 " 25° | Chloroform | 143 |
| " | 130.0 " 50° | Olive Oil | 12.5 |
| " | 705.0 " 61° | 95% Formic Acid | 13.6 (Aschan, 1913.) |

100 gms. sat. solution of bromo camphor in liquid sulfur dioxide contain about 61 gms. $C_{10}H_{15}OBr$ at ? t°. (De Carli, 1927.)

Freezing-point data are given for mixtures of:

Bromo camphor(d) + bromo camphor (l) (Timmermans, 1930; Padoa and Rotondi, 1912.)
" " + chloro camphors (Timmermans, 1930; Padoa, 1904.)
" " + borneol (Timmermans, 1930.)
" " + stearin (Batelli and Martinetti, 1885.)
" " + salol (Caille, 1909.)
" " + camphor (Hrynakowski, Staszewski and Szmyt, 1936.
" " + " + borneol " " " " "

**CARVOXIME** $C_{10}H_{14}$:NOH d and l.

Freezing-point data for mixtures of d and l carvoxime are given by Rheinboldt and Kircheisen, 1926; and by Timmermans, 1930.

**NITROSO DIETHYL ANILINE** $NOC_6H_4N(C_2H_5)_2$

Freezing-point data are given for mixtures of nitroso and nitro di ethyl aniline by Jaeger, 1905, 1907.

**PINENE** $C_{10}H_{16}$.

RECIPROCAL SOLUBILITY OF PINENE AND OTHER COMPOUNDS.
(Lecat, 1930.)

| Mixture of Pinene and: | t° of separation | Percent Pinene in Mixture |
|---|---|---|
| Ethyl acetate | 19.15 | 50.2 |
| α Di chlor hydrine | 43.3 | 63.5 |
| Methanol | -64.0 | 9.0 |
| Methyl malonate | 54.5 | 78.0 |

Freezing-point data for mixtures of d and l pinene are given by Ross and Sommerville, 1926.

**PINENE HYDROCHLORIDE** $C_{10}H_{16}.HCl$.

100 gms. 95% formic acid dissolve 1.2 gms. $C_{10}H_{16}.HCl$ at 16.8°. (Aschan, 1913.)

Freezing-point data for mixtures of pinene hydrochloride and l borneol are given by Timmermans, 1930.

## CAMPHENE $C_{10}H_{16}$.

Freezing-point data are given for mixtures of:

Camphene(d) + Camphene (l) (Ross and Sommerville, 1926.)
" + Camphor " " "
" + Tri chlor acetic acid (Timofeiew and Kravtzov, 1915, 1917.)
" + Methyl mustard oil (Kurnakov and Jefremow, 1912.)
" + Naphthalene " " "
" + Phenanthrene " " "
" + Benzene " " "

## FENCHONE d $C_{10}H_{16}O$.

Freezing-point data are given by Kremann and Dietrich, 1923, for mixtures of fenchone and each of the following compounds:
Di nitro phenol, hydroquinone, naphthols, nitro phenols, phenol, picric acid, pyrocatechol, pyrogallol and resorcinol.

## CAMPHOR $C_{10}H_{16}O$.

### Solubility of Camphor in Water and in Aqueous Solutions.

(Loo and Rimbach, 1919.)

| Solvent. | t°. | Gms. $C_{10}H_{16}O$ per 100 gms. sat. sol. |
|---|---|---|
| Water .. | 14-17 | 0.167 *a* |
| » .. | 15-20 | 0.170 (Rhode, 1922.) |
| » .. | 39 | 0.160 *a* |

| Solvent. | t°. | Gms. $C_{10}H_{16}O$ per 100 gms. sat. sol. |
|---|---|---|
| Ringer's solution ..... | 14-17 | 0.157 *c*. 0.173 *a* 0.204 *b* |
| » ..... | 35.5 | 0.140 *c* |
| » + 2% $C_2H_5OH$. | 14-17 | 0.238 *b* |
| » + 5% » | 14-17 | 0.270 *b* |

*a*. These determinations were made by shaking with just sufficient excess of active camphor to almost completely dissolve, and also by titrating the saturated solution with 0.1 n $KMnO_4$ solution.

*b*. In these cases a weighed amount of active camphor was shaken at room temperature with one liter of solvent for 24 hours. The undissolved camphor then filtered off, dissolved in 50 cc of 95 % $C_2H_5OH$ and from the rotation of the solution, the undissolved camphor was calculated

*c*. In these cases 300 cc. of the saturated aqueous solution were extrated with 50 cc. of benzene and the camphor in this determined by the optical method. The determination by Rhode was made by use of a stalagmometric method for estimating the dissolved camphor. (See Norcamphor, page 643 and Carvone, p. 676).

### Approximate Solubility of *d* Camphor in Several Solvents at Ordinary Temperature. (U. S. P., Squires; Greenish and Smith, 1903.)

| Solvent. | Parts Camphor per 100 Parts Solvent. | Solvent. | Parts Camphor per 100 Parts Solvent |
|---|---|---|---|
| Water | 0.08–0.14 | Chloroform | 300–400 |
| 90% Alcohol | 100 | Olive Oil | 25–33 |
| 95% Alcohol | 125 | Turpentine | 66 |
| Ether | 173 | Glacial Acetic Acid | 200 |
| Carbon Disulfide | Readily Soluble | Lanolin | 12.5 (Klose, 1907). |

Saturated solutions of *d* camphor and of *l* camphor in turpentine of $\alpha_D = 4.38$ (in a 10 cm. tube at 18°) were found to have $d_{16} = 0.9028$ and 0.9030 respectively; the $\alpha_D$ in a 10 cm. tube were +23.07 and −16.52 respectively. (Jones, 1907-08)

## Solubility of Camphor in Concentrated Aqueous Hydrochloric Acid. (Zaharia, 1899.)

(The dissolved camphor could not be determined by evaporating and weighing the residue on account of volatility; polarimetric methods could not be used on account of the interference of the HCl. The author, therefore, determined the densities ($H_2O$ at 4° in each case) of the pure solvent and saturated solution in each case, and assumed that the difference represented the weight of camphor dissolved. The saturated solutions were prepared by stirring the several mixtures with a glass stirring rod, at intervals, during 6 hours.)

| Solvent. | Densities at 0°. | | Densities at 10°. | | Densities at 20°. | | Densities at 40°. | |
|---|---|---|---|---|---|---|---|---|
| | Solvent. | Sat. Sol. | Solvent. | Sat. Sol. | Solvent. | Sat. Sol. | Solvent. | Sat Sol. |
| 27.2 % HCl | 1.145 | 1.143 | 1.140 | 1.138 | 1.135 | 1.133 | 1.125 | 1 123 |
| 30.6 " | 1.164 | 1.159 | 1.158 | 1.153 | 1.153 | 1.148 | 1 142 | 1 138 |
| 33 9 " | 1.181 | 1.167 | 1.175 | 1.163 | 1.169 | 1.159 | 1 157 | 1 149 |
| 34 98 " | 1.187 | 1.158 | 1.181 | 1 160 | 1 175 | 1 158 | 1 163 | 1 153 |
| 35.74 " | 1 191 | 1 140 | 1 185 | 1 148 | 1.179 | 1 153 | 1 167 | 1 153 |
| 36.38 " | 1.195 | 1.126 | 1 189 | 1 134 | 1 182 | 1 140 | 1 170 | 1.153 |
| 36.68 " | 1.197 | 1.116 | 1.190 | 1 124 | 1.184 | 1.134 | ... | ... |

## Equilibrium in the System Camphor, Alcohol and Water at Several Temperatures. (Scheringa, 1922.)

| Results at 0°. Gms. per 100 gms. Homogeneous mixture | | Results at 15°. Gms per 100 gms. Homogeneous mixture. | | Results at 25°. Gms per 100 gms. Homogeneous mixture. | | Results at 40°. Gms per 100 gms Homogeneous mixture. | |
|---|---|---|---|---|---|---|---|
| $C_{10}H_{16}O$. | $C_2H_5OH$. | $C_{10}H_{16}O$. | $C_2H_5OH$. | $C_{10}H_{16}O$. | $C_2H_5OH$. | $C_{10}H_{16}O$. | $C_2H_5OH$. |
| 1.9 | 36.1 | 1.6 | 30.6 | 1 5 | 29.2 | 4.4 | 30.8 |
| 4 8 | 42.8 | 4.2 | 37.7 | 4.65 | 36.0 | 6.2 | 35.1 |
| 10 5 | 47.2 | 7.4 | 42.2 | 7.0 | 39.4 | 16.7 | 38.9 |
| 12.1 | 48.1 | 11 1 | 44.3 | 10.3 | 41.3 | 31.0 | 38.8 |
| 18 3 | 50 9 | 19.9 | 46.5 | 14.3 | 42.8 | 51.3 | 34.2 |
| 21.8 | 50.9 | 30.8 | 46.2 | 22.0 | 43.9 | 59.9 | 31.5 |
| 34.4 | 49.7 | 43.8 | 43.8 | 29.1 | 43.6 | 62.8 | 30.5 |
| 40.3 | 49.2 | 51.4 | 42.1 | 41.3 | 41.3 | 70.5 | 29.5 |
| 48.6 | 48.5 | 54.8 | 41.1 | 56.1 | 37.36 | | |
| 50.9 | 49.1 | | | 61.0 | 36.5 | | |
| | | | | 62.8 | 35.9 | | |
| | | | | 63.8 | 36.2 | | |

## Distribution of Camphor Between Methyl Alcohol and Oil of Vaseline at 25°.

(Kozakewitch, 1935.)

| Gm. Mols. $C_{10}H_{16}O$ per 1000 gms. | | $\frac{1}{2}$ | Gm. Mols. $C_{10}H_{16}O$ per 1000 gms. | | $\frac{1}{2}$ |
|---|---|---|---|---|---|
| $CH_3OH$ layer(1) | Oil layer(2) | | $CH_3OH$ layer(1) | Oil layer(2) | |
| 0.0868 | 0.0207 | 4.2 | 0.217 | 0.0611 | 3.5 |
| 0.0907 | 0.0291 | 3.1 | 0.222 | 0.0583 | 3.8 |
| 0.116 | 0.0317 | 3.6 | 0.251 | 0.0682 | 3.7 |
| 0.136 | 0.0355 | 3.8 | 0.309 | 0.0767 | 4.0 |
| 0.174 | 0.0453 | 3.8 | 0.340 | 0.0920 | 3.7 |
| 0.188 | 0.0563 | 3.3 | 0.346 | 0.0979 | 3.5 |

The author also gives results showing the effect of increasing amounts of a number of inorganic salts upon the above distribution.

Experiments showing the partition of d Camphor between ligroin on the one hand and either concentrated sulfuric or phosphoric acid on the other, are given by Baker, 1932.

## CAMPHOR

Freezing-point data for mixtures of d and l camphor are given by Ross and Sommerville, 1926. Results are given for mixtures of camphor and:

Acetamide(8)(11)
Anthracene(8)(11)
Benzoic acid(8)(10)
Borneol(6)(19)(20)(21)(24)
Brom camphor(6)
Chloral hydrate(21)
Cinnamic acid(8)
Di bromo benzene(8)(11)
Di nitro benzene(8)(11)
Di nitro phenols(12)
Hydroquinone(8)(12)(18)
Mentho(18)
Methyl benzene(8)
Chlor acetic acid(18)
Chloro nitro benzenes(11
Di phenyl(27)
Di phenyl amine(29)
Methyl senevol(8)(11)
Naphthalene(5)(8)(10)
Naphthols(4)
Naphthylamine(10)(28)
Nitranilines(8)(11)
Nitric acid(22)
Nitro naphthalene(10)
Nitro phenols(12)
Phenol(23)(13)(26)
Phosphoric acid(22)
Picric acid(12)
Phthalic anhydride(8)(11)
Pyrocatechol(8)(12)
Methyl iodide(11)
Nitro penta erythritol (30)
Pyrogallol(10)(12)
Resorcinol(4)(8)(13)
Saiol(2)(4)(13)(16)
Salicylic acid(15)(8)(11)(14)
Sulfur dioxide(3)
Thymol(1)(7)
Tetra nitro methyl aniline(9)
Toluidine(8)(11)
Tri nitro toluene(8)(11)(25)
Urethan(17)
Thio carbanilide(11)
Tri methylene tri nitramine(31)
Tri nitro benzene(11)

(1) Astruc and Cambe, 1917; (2) Barnouvin, 1893; (3) Bellucci and Grassi, 1913, 1914; (4) Caille, 1909, 1910; (5) Girard, 1891; (6) Hrynakowski, Staszewski and Szmyt, 1936; (7) Hrynakowski and Szmyt, 1935; (8) Jefremow, 1912, 1913; (9) Jefremow and Tichomirowa, 1928; (10) Journiaux, 1912; 1913; (11) Jefremow, 1915, 1916; (12) Kremann and Odelga, 1921; (13) Leger, 1880; (14) Lajoux, 1917; (15) LeFevre and Tideman, 1931; (16) LeFevre and Webb, 1931; (17) Migliacci and Calo, 1927; (18) Pawlewski, 1913; (19) Ross and Sommerville, 1926; (20) Timmermans, 1930; (21) Tsakalotos, 1915; (22) Zukow, and Kasatkin, 1909; (23) Wood and Scott, 1910; (24) Vanstone, 1909; (25) Giua, 1916. (26) Günther and Peiser, 1927; (27) Maki and Nagai, 1923; (28) Puschin and Zwadinovic, 1933; (29) Sswetlow, 1933; (30) Urbanski, 1934; (31) Urbanski and Rabek-Gawronska, 1934.

## CAMPHORIC ACID $C_8H_{14}(COOH)_2$.

100 gms. of water dissolve 0.8 gm. $C_8H_{14}(COOH)_2$ at 25°, and 10 gms. at the b. pt. (U.S.P.)

SOLUBILITY OF CAMPHORIC ACID IN AQUEOUS SOLUTIONS OF ALCOHOL AT 25°.
(Seidell, 1908, 1910.)

| Wt. % $C_2H_5OH$ in Solvent. | $d_{25}$ of Sat. Sol. | Gms. $C_8H_{14}(COOH)_2$ per 100 Gms. Sat. Sol. | Wt. % $C_2H_5OH$ in Solvent. | $d_{25}$ of Sat. Sol. | Gms. $C_8H_{14}(COOH)_2$ per 100 Gms. Sat. Sol. |
|---|---|---|---|---|---|
| 0 | 1 | 0.754 | 60 | 1 | 45 |
| 10 | 1 | 1.60 | 70 | 1 | 49 |
| 20 | 1 | 6.30 | 80 | 0.995 | 51.20 |
| 30 | 1 | 14 | 90 | 0.980 | 51.40 |
| 40 | 1 | 26 | 96.3 | 0.970 | 50.37 |
| 50 | 1 | 31 | 100 | 0.960 | 50.10 |

**CAMPHORIC ACID** $C_8H_{14}(COOH)_2$.

100 gms. glycerol of $d = 1.2326 (= 86.5\ \%)$ dissolve 2.36 gms. $C_8H_{14}(COOH)_2$ at 20°.
" " " $d = 1.2645 (= 98.6\ \%)$ " 4.32 " " "
(Holm, 1921-1922.)

100 gms. Para cymene (b. pt. 176-176°.5) dissolve 1.53 gms. $C_8H_{14}(COOH)_2$ at 100°.
(Wheeler, 1920.)

DISTRIBUTION OF CAMPHORIC ACID AT 25° BETWEEN: (Smith, 1921-1922.)

Water and Chloroform.

| Millimols. per liter of | | |
|---|---|---|
| $H_2O$ layer ($C_1$). | $CHCl_3$ layer ($C_2$). | $\frac{C_2}{C_1}$. |
| 4.30 | 0.525 | 0.116 |
| 7.95 | 1.50 | 0.189 |
| 19.25 | 10.35 | 0.538 |

Water and Xylene.

| Millimols. per liter of | | |
|---|---|---|
| $H_2O$ layer ($C_1$). | $C_6H_4(CH_3)_2$ layer ($C_2$). | $\frac{C_2}{C_1}$. |
| 3.922 | 0.0776 | 0.0198 |
| 9.722 | 0.278 | 0.0286 |
| 19.166 | 0.834 | 0.0436 |

SOLUBILITY OF CAMPHORIC ACID IN SEVERAL SOLVENTS.

| Solvent. | t°. | $d_{25}$ of Sat. Sol. | Gms. $C_8H_{14}(COOH)_2$ per 100 Gms. Solvent. | Solvent. | t°. | $d_{25}$ of Sat. Sol. | Gms. $C_8H_{14}(COOH)_2$ per 100 Gms. Solvent. |
|---|---|---|---|---|---|---|---|
| Amyl Alcohol(iso) | 25 | 0.907 | 50(3) | Carbon Disulfide | 25 | 1.258 | 0.020(3) |
| Butyl Alcohol(iso) | 22.5 | ... | 54.1(1) | Chloroform | 25 | ... | 0.153(3) |
| Ethyl Alcohol | 0 | ... | 84.7(1) | Cumene | 25 | 0.890 | 0.197(3) |
| " " | 15.1 | ... | 112(2) | Ether (abs.) | 25 | 0.922 | 91.40(3) |
| " " | 62.5 | ... | 147(2) | 95% Formic Acid | 18.5 | ... | 8.68(4) |
| Methyl Alcohol | 0 | ... | 116.3(1) | Ligroin | 25 | 0.714 | 0.007(3) |
| " " | 22.5 | ... | 131.1(1) | Nitrobenzene | 25 | 1.2 | 0.5(3) |
| Propyl Alcohol | 0 | ... | 42.2(1) | Spts. Turpentine | 25 | 0.852 | 1.74(3) |
| " " | 22.5 | ... | 61 (1) | Toluene | 25 | 0.862 | 0.15(3) |
| Benzene | 25 | 0.873 | 0.008(3) | Xylene | 25 | 0.859 | 0.23(3) |

(1) Timofeiew (1914); (2) Beilstein; (3) Seidell (1910); (4) Aschan, (1913).

Data for the distribution of camphoric acid between water and ether at 25° are given by Chandler (1908). Data for the freezing points of mixtures of *d* and *l* camphoric acid and *d* and *l* isocamphoric acid are given by Centnerszwer (1899).

Results for mixtures of stereo isomeric camphoric acids, camphoric acid methyl esters and camphoric anhydrides are given by Ross and Sommerville, 1926.

**CYMENE DISULFONAMIDE** $C_{10}H_{12}(SO_2.NH_2)_2$.

100 gms. of ether dissolve 0.0727 gm. cymene disulfonamide at 25°. (Phillips, 1924.)

This author also gives f. pt. data for the system α cymene sulfonamide + β cymene sulfonamide.

**CAMPHOROXIME** $C_{10}H_{16}$:NOH *d* and *l*.

100 gms. turpentine dissolve 8.68 gms. *d* oxime at 18°, $d_{18}$ = 0.8784, $\alpha_D$ = 2.30 in 10 cm. tube.

100 gms. turpentine dissolve 8.69 gms. *l* oxime at 18°, $d_{18}$ = 0.8782, $\alpha_D$ = 18.24 in 10 cm. tube.

$\alpha_D$ of the turpentine = 4.38 in a 10 cm. tube at 18°.

In the case of results in *l* amyl bromide the $d_{18}$ = 1.199 in both cases and the $\alpha_D$ was −3.55 (10 cm. tube) for the *d* oxime and + 11.48 for the *l* oxime. The $\alpha_D$ of the amyl bromide was +4.6 in 10 cm. tube at 18°. The results show that the solubility and rotatory power of the *d* and *l* isomerides are identical in an optically active as well as in an inactive solvent.

Freezing-point data are given for mixtures of *d* and *l* camphoroxime by Beck (1904) and Adriani (1900).

**DECALIN** (Decahydronaphtalene) $C_{10}H_{18}$.

Solubility in Liquid Sulfur Dioxide (98.85 % $SO_2$).
(Zerner, Weisz and Opalski, 1922.)

The determinations were made in sealed resistance glass tubes. Weighed amounts of the constituents were introduced and the temperatures determined at which homogeneous mixing or slight clouding occurred. The Decalin had a corrected b. pt. of 188-189°. It had $d_{20} = 0.8857$ and $n\frac{15°}{D} = 1.4753$.

| t° of solution. | Gms. $C_{10}H_{18}$ per 100 gms. sat. sol. | t° of solution. | Gms. $C_{10}H_{18}$ per 100 gms. sat. sol. |
|---|---|---|---|
| —14.5 | 1.62 | 38.0 | 13.80 |
| + 0.1 | 2.86 | 50.75 | 27.34 |
| 18.0 | 5.53 | 51.50 | 52.48 |
| 28.5 | 9.72 | 22.25 | 81.39 |

**TERPINEOL** $\alpha C_{10}H_{18}O$ and $\beta C_{10}H_{18}O$.

Solubility of α Terpineol and of β Terpineol in Water. (Rhode, 1922.)

By means of a stalogmometric method (see Carvone, p. 676) the solubility of α terpineol in water was found to be 1.98 gms. (= 0.0129 mols.) per liter at 15-20°. The result for β terpineol was 2.20 gms. (= 0.0143 mols.) per liter at 15-20°.

**MENTHONE** $C_{10}H_{18}O$.

Freezing-point data for mixtures of menthone and menthole are given by Vanstone, 1909.

**BORNEOL** $C_{10}H_{17}OH$.

Solubility of Borneol in Water.

Using a stalogmometric method involving a comparison of the number of drops per unit of time in the case of saturated solutions and their dilutions, in comparison with similar determinations upon a series of solutions of known content, Rhode, 1922, found that 1 liter of $H_2O$ dissolves 0.64 gm. (= 4.2 millimols.) borneol at 15-20°.

By means of an optical method in which an interferometer of the type described by Jamin (*Ann. chim. phys.*, 52, 171, 1858) was used, Mitchell, 1926, found that 1 liter of $H_2O$ dissolves 0.693 gm. borneol at 15° and 0.740 gm. at 25°.

100 gms. abs. alcohol dissolve 175.5 gms. borneol at 20-25°. (Puchier and Dehn, 1921.)

Freezing-point lowering data for mixtures of *d* borneol and *l* borneol, *d* borneol and *d* camphor, *d* bornyl hydrogen phthalate and *l* bornyl hydrogen phthlate are given by Ross and Somerville, 1926.

Freezing-point data for mixtures of stereoisomeric Borneols and each of the following stereoisomeric compounds are given by Timmermans, 1930. Bromo camphor, chloro camphor, camphor and pinene hydrochloride.

Results for mixtures of Borneol and camphor are also given by Vanstone, 1909, and Hrynakowski, Staszewski and Szmyt, 1936.

**CINEOLE** (Eucalyptol) $C_{10}H_{18}O$.

SOLUBILITY OF CINEOLE IN WATER. (Earle, 1918.)

| t°..... | 1°.5. | 7°.8. | 10°.0. | 21°0. | 40°.0. | 59°.0. |
|---|---|---|---|---|---|---|
| Gms. $C_{10}H_{18}O$ per 100 gms. $H_2O$. | 0.64 | 0.57 | 0.54 | 0.35 | 0.21 | 0.19 |

Freezing-point data are given for mixtures of Cineole and:

Amido phenols(1)
Cresols(1)
Ethyl phenols(2)
Guaiacol(1)
Hydroquinone(1)
Methyl ethyl phenols(2)
Methyl salicylate(1)
Naphthalene(1)
Naphthols(1)
Nitro phenols(1)
Oxy benzoic acid(1)
Phenol(1)
Phenyl salicylate(1)
Pyro catechol(1)
Resorcinol(1)
Thymol(1)
Xylenols(2)

(1) Bellucci and Grassi; 1913; (2) Morgan and Pettet, 1935.

**SEBACIC ACID** $(CH_2)_8(COOH)_2$.

100 gms. 95% formic acid dissolve 1.05 gm. sebacic acid at 19°. (Aschan, 1913.)

DISTRIBUTION OF SEBACIC ACID BETWEEN WATER AND ETHER AT 25°.
(Chandler, 1908.)

| Mol. Concentration of Sebacic Acid in: Aq. Layer | Ether Layer. | Ratio. |
|---|---|---|
| 0.00062 | 0.0291 | 0.0213 |
| 0.00058 | 0.0272 | 0.0213 |
| 0.00047 | 0.0213 | 0.0221 |
| 0.00036 | 0.0155 | 0.0232 |

**HEXYL SUCCINIC ACID** (d) $COOHCH(C_6H_{13})CH_2COOH$.

Freezing-point data for mixtures of d and of l hexyl succinic acid with d and with l propyl succinic acid are given by Timmermans and Van der Haegen, 1933.

**HEPTYL MALONIC ACID** $CH(C_7H_{15})(COOH)_2$.

100 gms. $H_2O$ dissolve 0.184 gm. $CH(C_7H_{15})(COOH)_2$ at 25°.
100 gms. $C_6H_6$ " 0.0917 " " " "
(Verkade and Coops, 1930a.)

**ETHYL ADIPATE** $(CH_2)_4(COOC_2H_5)_2$.

100 cc $H_2O$ dissolve 0.423 gm. $(CH_2)_4(COOC_2H_5)_2$ at 20°.
(Sobotka and Kahn, 1931.)
100 gms. $H_2O$ dissolve 0.426 gm. $(CH_2)_4(COOC_2H_5)_2$ at 30°.
(Gross, Saylor and Gorman, 1933.)

**BORNYL AMINE** $C_{10}H_{17}NH_2$.

DISTRIBUTION OF BORNYL AMINE BETWEEN WATER AND XYLENE AT 25°.
(Smith, 1921-1922.)

| Millimols. $C_{10}H_{17}NH_2$ per liter of $H_2O$ layer ($C_1$). | $C_6H_4(CH_3)_2$ layer ($C_2$) | $\frac{C_2}{C_1}$. |
|---|---|---|
| 0.0455 | 2.50 | 55.0 |
| 0.0570 | 3.16 | 55.5 |
| 0.08125 | 4.72 | 58.0 |

**CAMPHYLAMINE** $C_9H_{15}CH_2.NH_2$.

DISTRIBUTION BETWEEN WATER AND XYLENE AT 25°. (Smith, 1921-1922.)

| Milllmols. per liter of | | |
|---|---|---|
| $H_2O$ layer ($C_1$). | $C_6H_4(CH_3)_2$ layer ($C_2$). | $\frac{C_2}{C_1}$. |
| 0.0182 | 0.982 | 54.0 |
| 0.0396 | 2.210 | 55.8 |
| 0.0625 | 3.587 | 57.9 |

**MENTHENON** $CH_3.CH\langle\begin{matrix}CO.CH\\CH_2.CH_2\end{matrix}\rangle C.CH(CH_3)_2$.

**MENTHOL** $(CH_3)_2CH.CH\langle\begin{matrix}CH(OH)CH_2\\CH_2CH_2\end{matrix}\rangle CH.CH_3$.

**MENTHON** $(CH_3)_2CH.CH\langle\begin{matrix}CO.CH_2\\CH_2.CH_2\end{matrix}\rangle CH.CH_3$.

SOLUBILITY OF EACH IN WATER AT ROOM TEMPERATURE. (Rhode, 1922.)

The author used a stalogmometric method, according to which the number of drops per unit of time in the case of saturated solutions and their dilutions were compared with similar determinations upon a series of solutions of known content. For obtaining saturation long periods of shaking were often necessary.

| Compound. | Per liter of sat. sol. | |
|---|---|---|
| | Grams. | Milllmols. |
| Menthenon..... | – | 15.1 |
| Menthol..... | 0.42 | 2.7 |
| Menthon..... | 0.69 | 4.5 |

One cc. of 95% alcohol dissolves about 5 gms. menthol at room temp. (Greenish and Smith, 1903.)

100 gms. sat. solution of menthol in liquid ammonia contain about 16 gms. $C_{10}H_{20}O$ at ? t°.

100 gms. sat. solution of menthol in liquid sulfur dioxide contain about 27 gms. $C_{10}H_{20}O$ at ? t°. (De Carli, 1927.)

Freezing-point data are given for mixtures of Menthol and:

Acetanilide(7)(14)
Antipyrine(1)(2)(6)
" + Phenacetine(5)
Anethol(15)
Benzene(4)
Camphor(9)
Chloral hydrate(8)
Ethylene bromide(4)
Guaiacol(1)(6)
Iodo biphenyl(12)
Menthane(16)
Menthone(16)
Methyl urethan(15)
Naphthalene(15)
Nitro benzene(15)
Phenacetine(6)
" + antipyrine(5)
" + urethan(5)
Phenylene diamine(13)
Quinine(1)(6)
Salol(3)(6)
Sarcosine anhydride(10)
Tetra methyl diamino benzo phenone(11)
Toluidine(8)
Urea(6)
Urethan(1)(6)
" + Phenacetine(5)
Michler's ketone(17)

(1) Adamanis, 1933; (2) Angeletti, 1928; (3) Bellucci, 1912; 1913; (4) Dahms, 1895; (5) Hrynakowski, 1934; (6) Hrynakowski and Adamanis, 1933; ( ) Hrynakowski and Adamanis, 1933a; (8) Pawlewski, 1893; (9) Pawlewski, 1913; (10) Pfeiffer and Angern, 1926; (11) Pfeiffer, Goebel and Angern, 1925; (12) Pfeiffer, Schmitz and Inoue, 1929; (13) Puschin and Dezelic, 1938; (14) Quercigh and Cavagnari, 1912; (15) Scheuer, 1910; (16) Vanstone, 1909; (17) Pfeiffer, 1924.

Freezing-point data for mixtures of d and l iso menthol are given by Read, Robertson and Cook, 1927.

**CAPRIC ACID** $CH_3(CH_2)_8COOH$.

Freezing-point data for mixtures of capric and lauric acids are given by Kulka and Sandin, 1937.

**ETHYL CAPRYLATE** $CH_3(CH_2)_6COOC_2H_5$.

100 cc $H_2O$ dissolve 0.007 gm. $CH_3(CH_2)_6COOC_2H_5$ at 20° (Sobotka and Kahn, 1931.)

**TRI CAPRIN** $C_5H_5[CH_3(CH_2)_8COO]_3$.

SOLUBILITY OF TRI CAPRIN IN SEVERAL SOLVENTS.
(Loskit, 1928.)

The determinations were made by the thermic, the sealed tube and the analytical method. The author's results were plotted and the following table constructed from the curves.

| t° | Gms. $C_3H_5[CH_3(CH_2)_8COO]_3$ per 100 gms. sat. sol. in: | | | t° | Gms. $C_3H_5[CH_3(CH_2)_8COO]_3$ per 100 gms. sat. sol. in: | | |
|---|---|---|---|---|---|---|---|
| | $C_6H_6$ | $(C_2H_5)_2O$ | $CS_2$ | | $C_6H_6$ | $(C_2H_5)_2O$ | $CS_2$ |
| -15 | — | 2.5 | — | 2.5 | 46.0(20.) | 29.0 | 40.0 |
| -10 | — | 6.5 | 8.0 | 5.0 | 51.0( 7.) | 37.5 | 48.0 |
| - 7.5 | (51.) | 9.0 | 13.0 | 10 | 61.5 | 54.0 | 59.0 |
| - 5.0 | (46.) | 12.0 | 19.0 | 15 | 71.5 | 66.5 | 70.0 |
| - 2.5 | (40.) | 16.5 | 25.0 | 20 | 81.5 | 80 | 81.0 |
| - 1.5 | 37.0(37.) | — | — | 25 | 90.0 | 90 | 91.0 |
| 0 | 40.0(32)) | 22.2 | 32.2 | 25 | | | |

The author also gives the following results for the solubility of tricaprin in ethyl alcohol.

| t° | Gms. tricaprin per 100 gms. sat. sol. | t° | Gms. Tricaprin per 100 gms. sat. sol. | t° | Gms. tricaprin per 100 gms. sar. sol. |
|---|---|---|---|---|---|
| 9.5 | 0.44 | 25.1 | 9.87 | 69 | 68.40 |
| 13.8 | 0.99 | 24.9 | 11.83 | 69 | 73.80 |
| 17.6 | 2.01 | 25.4 | 12.72 | 65 | 83.3 |
| 20.8 | 3.86 | 25.2 | 14.36 | 55 | 85.24 |
| 23.4 | 5.81 | 58.5 | 29.32 | 35 | 92.61 |
| 24.2 | 7.44 | 60.8 | 35.28 | | |

**TERPIN HYDRATE** $C_{10}H_{18}(OH)_2.H_2O$.

100 cc. $H_2O$ dissolve 0.36 gm. terpin hydrate at 15–20°.
100 cc. 90% alcohol dissolve 7.1 gms. terpin hydrate at 15–20°.
(Squire and Caines, 1905.)

Freezing-point data for mixtures of terpin hydrate and salol are given by Angeletti, 1928.

**DECANE** $CH_3(CH_2)_8CH_3$.

The critical solution temperature of mixtures of decane and liquid sulfur dioxide is 36.5° and the reciprocal solubility curve at this temperature is practically flat between the concentrations 60-90 mol. percent $SO_2$. (Leslie, 1934.) The C.S.T. is given by Seyer and Todd, 1931, as 37.3°.

Freezing-point data for mixtures of decane and dicetyl are given by Seyer, 1938.

**AGARIC ACID** $C_{10}H_{30}O_5.H_2O$.

100 grams trichloroethylene dissolve 0.014 gram agaric acid at 15°.

(Wester and Bruins, 1914.)

**β NAPHTHOIC ACID** $C_{10}H_7COOH$.

One liter of aqueous solution contains 0.058 gm. $C_{10}H_7COOH$ at 25°.

(Paul, 1894.)

Freezing-point data for mixtures of α Naphthoic acid and tetra methyl diamino benzo phenone are given by Pfeiffer, Goebel and Angern, 1925.

**βMETHYL NAPHTHALENE** $C_{10}H_7(CH_3)$.

Freezing-point data for mixtures of β methyl naphthalene with β naphthol, with β naphthylamine and with β chloro naphthalene are given by Grimm, Gunther and Titus, 1931.

Dihydro **β NAPHTHOIC ACIDS** $C_{10}H_9COOH$ (118° and 161° isomers).

SOLUBILITY OF EACH ISOMER, DETERMINED SEPARATELY, IN WATER.
(Derick and Kamm, 1916.)

| t°. | cc. 0.01 *n* $Ba(OH)_2$ Solution Required per 10 cc. of the Sat. Solution of the: | |
|---|---|---|
| | 118° Isomer. | 161° Isomer. |
| 0 | 0.39 | 0.19 |
| 20 | 0.56 | 0.34 |
| 40 | 1.34 | 0.69 |
| 55–56 | 2.89 | 1.45 |
| 71–72 | 6.7 | 3.48 |
| 80 | 9.3 | 4.68 |
| 90 | 14.6 | 8 |
| 96–97 | 20.1 | 10.5 |

**β NAPHTHOL METHYL ESTER** (1-Methyl-β-Naphthol) $CH_3C_{10}H_6OH$.

Freezing-point data for mixtures of β naphthol methyl ester with m dinitro benzene and with 1,2,4 dinitro toluene are given by Guia and Marcellino, 1920.

**DI ANISAL ACETONE** (3-Buten-2-one, 4 p anisyl-) $CH_3OC_6H_4CH:CHCOCH_3$.

Freezing-point data for mixtures of dianisal acetone and acenaphthene are given by Pfeiffer, 1924.

**TRI NITRO PHENOXY PROPIONIC ACID ETHYL ESTER** $CH_3CH[OC_6H_2(NO_2)_3]CO_2C_2H_5$

Freezing-point data for mixtures of α 2,4,6 tri nitro phenoxy propionic acid ethyl ester and di phenyl amine are given by Hertel and Römer, 1930.

**QUINOLINE ETHIODIDE** $C_9H_7N.C_2H_5I$.

100 gms. $H_2O$ dissolve 301.3 gms. $C_9H_7N.C_2H_5I$ at 25°. (Peddle and Turner, 1913)
100 gms. $CHCl_3$ dissolve 1.78 gms. $C_9H_7N.C_2H_5I$ at 25°. "

## ANTIPYRINE $N(CH_3)N(C_6H_5)COCH:CCH_3$.

### Solubility in Water, Determined by the Freezing-Point Method.

(Kremann and Janotzky, 1923.)

| t° of primary crystallization. | Gms. Antipyrine per 100 gms. sat. sol. | Solid Phase. | t° of primary crystallization. | Gms. Antipyrine per 100 gms. sat. sol. | Solid Phase. |
|---|---|---|---|---|---|
| —0.9..... | 16.7 | Ice | 20.2..... | 57.3 | Antipyrine |
| —1.7..... | 26.2 | » | 24.9..... | 61.9 | » |
| —2 8..... | 35.4 | » | 30.4..... | 67.0 | » |
| —3.3 (Eutec.).. | 37.5 | » + Antipyrine | 38.0..... | 72.5 | » |
| 0.0..... | 39.1 | Antipyrine | 46.5..... | 78.1 | » |
| 2.5..... | 41.2 | » | 56.0..... | 83.0 | » |
| 6.1..... | 43.6 | » | 70.0..... | 88.5 | » |
| 7.0..... | 45.5 | » | 88.0..... | 94.7 | » |
| 11.0..... | 47.8 | » | 95.0..... | 96.1 | » |
| 15.5..... | 52.6 | » | 109.0..... | 100.0 | » |

The authors also give data for mixtures of antipyrine and caffeine and for mixtures of antipyrine, caffeine and water.

### Solubility of Antipyrine in Various Solvents.

100 gms. water dissolve 80 gms. $C_{11}H_{12}N_2O$ at 15°. (Greenish and Smith, '03.)
" " " 100 " " 25°. (U. S. P.)
" alcohol " 100 " " " "
" 90% alcohol " 75.2 " " " "
" chloroform " 100 " " " "
" ether " 1.3 " " " (Enell, 1899.)
" pyridine " 38.0 " " at 20–25°. (Dehn, 1917.)
" 50% aq. pyridine " 79.61 " " " "

100 gms. abs. $C_2H_5OH$ dissolve 74.09 gm. Antipyrine at 20-25°.
100 gms. Quinoline » 19.00 » » at 20-25°.
100 gms. equi. mols. Quinoline and $C_2H_5OH$ dissolve 36.55+gm. Antipyrine at 20-25°. (Pucher and Dehn. 1921.)
100 gms. Glycerol of $d = 1.2326$ dissolve 21.4 gms. Antipyrine at 20°. (Holm, 1921, 1922.)
100 gms. » » $d = 1.2645$ » 17.3 » » at 20°. » »
100 gms. Cymene » 2.09 » » at 30°. (Wheeler, 1920.)
100 gms. 86.5 % Glycerol ($d = 1.2326$) dissolve 1,9 gms. *Dimethyl amino antipyrine* and 100 gms. 98.5 % Glycerol ($d = 1.2645$) dissolve 1.5 gms. at 20°. (Holm, 1921, 1922.)

100 gms. $C_6H_6$ dissolve 8.1 gms. Antipyrine at 25°. (Warren, 1933.)
" " $CCl_4$ " 1.03 " " " " " "

### Distribution of Antipyrine at 25° Between. (Emery and Wright, 1921.)

| Water and Chloroform. Gms. Antipyrine per 100 cc. | | 1.0 normal Aq. $H_2SO_4$ and $CHCl_3$. Gms. Antipyrine per 100 cc. | | 0.1 normal o $C_6H_4(OH)COONa$ and $CHCl_3$. Gms. Antipyrine per 100 cc. | |
|---|---|---|---|---|---|
| $H_2O$ layer. | $CHCl_3$ layer. | Aq. layer. | $CHCl_3$ layer. | Aq. layer. | $CHCl_3$ layer. |
| 0.0076 | 0.1924 | 0.0908 | 0.1092 | 0.0092 | 0.1908 |
| 0.0074 | 0.3936 | 0.1884 | 0.2116 | 0.0212 | 0.3788 |
| 0.0528 | 0.9472 | 0.4644 | 0.5356 | 0.0524 | 0.9416 |
| 0.1208 | 1.8792 | 0.9452 | 1.0548 | 0.416 | 4.584 |
| 0.3950 | 4.605 | 2.315 | 2.685 | 0.424 | 4.576 |
| 1.1600 | 8.840 | 4.568 | 5.432 | 1.25 | 8.75 |

## The Solidification Points of Mixtures of Antipyrine and Salol.

(Bellucci, 1912, 1913.)

| Initial t° of Solidification. | Gms. $C_{11}H_{12}N_2O$ per 100 Gms. Mixture. | Initial t° of Solidification. | Gms. $C_{11}H_{12}N_2O$ per 100 Gms. Mixture. |
|---|---|---|---|
| 112.6 | 100 | 65 | 40 |
| 104.5 | 90 | 53 | 30 |
| 98 | 80 | 30 Eutec. | 17 |
| 91 | 70 | 34 | 20 |
| 83 | 60 | 35 | 10 |
| 75 | 50 | 42 | 0 |

Freezing-point data are given for mixtures of Antipyrine and:

Acetanilide(3)(7)
" + Salicylic acid(10a)
" + Phenacetine(5)
Amino phenol(15)
Barbituric acid(13)
Butyl chloral hydrate(13)
Benzoic acid(19)
Benzoic + Salicylic acid(5)
Caffeine(11)
Carbazole(12)
Chloral hydrate(18)
Cholesterine(13)
Di phenyl amine(12)
Di methyl glyoxime(20)
Di nitro phenol(21)
Hydroquinone(17)(21)
" + pyrocatechol(5)(9)
Luminal(15)(13)
Mannite(13)
Menthol(1)(2)(6)
" +Phenacetine(5)
Methyl acetanilide(2)(4)
Methyl barbituric acid(13)
Methyl ethyl glyoxime(20)
Methyl glyoxime(20)
Methyl oxy benzoates(15)
Methyl phenyl voluntal(14)
Methyl veronal(13)
Naphthols(16)(21)
Naphthylamine(12)
Nitro phenol(21)
Orthoform neu(15)
Phenacetine(1)(6)
" + Acetanilide(5)
" + Menthol(5)
" + Quinine(5)
" + Salol(5)
" + Sulfonal(5)
" + Urea(5)
" + Urethan(5)
Phenylene diamine(12)
Phenyl urethan(22)
Phenyl veronal(13)
Phenyl voluntal(14)
Pyrocatechol(21)
" + Resorcine(5)
" + Hydroquinone(9)(5)
Pyrogallol(21)
Quinine(1)(6)
" + Phenacetine(5)
Resorcine(16)(21)
" + Urea(5)
Resorcine + Pyrocatechol(5)
Phenol (21)
Salicylic acid(21)
" " + Benzoic Acid(5)
Salicylic acid + Urea(5)
Salol(1)(6)(16)
" + Phenacetine(5)
Salipyrine + Urea(5)
Sulfonal + Urea(5)
" + Phenacetine(5)
Thiosinamine(22)
Thymol(10b)
Urea(1)(6)
" + Phenacetine(5)
" + Resorcine(5)
" + Salicylic acid(5)
" + Salipyrine(5)
" + Sulfonal(10)
" + Urethan(5)(8)
Urethan(6)(14)
" + Phenacetine(5)
" + Urea(5)(8)
Veronal(13)(12)
Voluntal(14)

Freezing-point data are given for mixtures of 1-phenyl-2,3, di-methyl-5-pyrazolone and: Barbital(12)(13)
Di phenyl amine(12)

(1) Adamanis, 1933; (2) Angeletti, 1928; (3) Comanducci, 1912; (4) Giua, 1916; (5) Hrynakowski, 1934; (6) Hrynakowski and Adamanis, 1933; (7) Hrynakowski and Adamanis, 1933a; (8) Hrynakowski and Adamanis, 1935; (9) Hrynakowski and Adamanis, 1937; (10) Hrynakowski and Szmyt, 1938a; (10a) Hrynakowski and Szmyt, 1935b; (10b) Hrynakowski and Szmyt, 1935; (11) Kremann and Janetzky, 1923; (12) Pfeiffer and Angern, 1926; (13) Pfeiffer and Seydel, 1928; (14) Pfeiffer and Seydel, 1928a; (15) Pfeiffer and Seydel, 1928b; (16) Quercigh and Cavagnari, 1912; (17) Rheinboldt, Henning and Kircheisen, 1925; (18) Tsakalotos, 1913; (19) Kremann and Marktl, 1920; (20) Semeria and Bocca, 1926; (21) Kremann and Haas, 1919; (22) Mazetti, 1926.

## l TRYPTOPHAN $C_6H_4NHCH{:}CCH_2CH(NH_2)COOH$.

### Solubility of Tryptophan in Water.
(Dalton and Schmidt, 1935.)

The results of 18 determinations at 8 temperatures between 0° and 65° were used for calculating the solubility equation and from this the following values for 5° intervals were obtained. The values above 70° are probably less accurate than those at the lower temperatures.

| t° | Gm. l Tryptophan per 1000 gms. $H_2O$ | t° | Gm. l Tryptophan per 1000 gms. $H_2O$ | t° | Gm. l Tryptophan per 1000 gms. $H_2O$ |
|---|---|---|---|---|---|
| 0 | 8.23 | 30 | 12.23 | 60 | 20.57 |
| 5 | 8.72 | 35 | 13.23 | 65 | 22.70 |
| 10 | 9.27 | 40 | 14.35 | 70 | 25.14 |
| 15 | 9.88 | 45 | 15.62 | 75 | 27.95 |
| 20 | 10.57 | 50 | 17.06 | 100 | 49.87 |
| 25 | 11.36 | 55 | 18.70 | | |

### Solubility of Tryptophan in Water and in Aqueous Salt Solutions at 22-23°.
(Pfeiffer and Angern, 1924.)

The determinations were made by the method described under Alanine, p. 1019.

| Solvent. | Gms. $C_{11}H_{12}N_2O_2$ per 100 cc. sat. sol. |
|---|---|
| Water | 1.306 |
| Aq. 0.2 molecular $CH_3COOK$ | 1.202 |
| » $(NH_4)_2SO_4$ | 0.588 |
| » NaCl | 1.080 |

100 cc Acetic Acid dissolve 0.85 gm. Tryptophan at 18°.
100 cc Butyric Acid dissolve 0.053 gm. Tryptophan at 18°.
(Przylecki and Kasprzyk-Czaykowska, 1938.)

## ETHYL COUMARIC ACID (Ethyl hydroxy cinnamic acid) $C_{11}H_{12}O_3$.

### Solubility of Ethyl Coumaric Acid and Other Compounds in Water.
(Roth and Stoermer, 1913.)

| Compound | Formula | t° | Gms. Compound per 1 liter |
|---|---|---|---|
| Ethyl Coumaric Acid | $C_{11}H_{12}O_3$ | 25 | 0.0910 |
| Ethyl Coumarinic Acid | $C_{11}H_{12}O_3$ | 25 | 0.577 |
| Acetyl Coumaric Acid | $C_{11}H_{11}O_4$ | 25 | 0.144 |
| Acetyl Coumarinic Acid | $C_{11}H_{10}O_4$ | 25 | 1.14 |

## BUTYL DINITRO BENZOATE $(NO_2)_2C_6H_3COOC_4H_9$

Freezing-point data for mixtures of butyl 3,5-di nitro benzoate and ethyl 3.5 di nitro benzoate are given by Caldwell and MacLean, 1933.

**METHOXY iso CHAVIBETOL** $(CH_3O)_2C_6H_4CH{:}CHCH_3$.

Freezing-point data for mixtures of methoxy iso chavibetol and methoxy iso eugenol are given by Hiraidzumi, 1932.

**CYTISINE** (Ulexine) $C_{11}H_{14}N_2O$ (m. pt. 151°–151.5°).

SOLUBILITY IN SEVERAL SOLVENTS AT 15°.
(Van de Moer, 1891.)

| Solvent. | Gms. $C_{11}H_{14}N_2O$ per 100 Gms. Sat. Sol. | Solvent. | Gms. $C_{11}H_{14}N_2O$ per 100 Gms. Sat. Sol. |
|---|---|---|---|
| Water | soluble in all proportions | Benzine | 1.26 |
| Alcohol | " " " | Petroleum Ether | insol. |
| Chloroform | " " " | Amyl Alcohol | 0.303 |
| Ether (*d* 0.725) | 0.302 | Carbon Disulfide | insol. |
| Ether, abs. | insol. | Ethyl Acetate | very soluble |

**PILOCARPINE** $C_{11}H_{16}N_2O_2$.

100 cc. oil of sesame dissolve 0.3142 gm. $C_{11}H_{16}N_2O_2$ at 20°. (Zalai, 1910.)

**PILOCARPINE HYDROCHLORIDE** $C_{11}H_{16}N_2O_2.HCl$, Pilocarpine Nitrate $C_{11}H_{16}N_2O_2.HNO_3$, and Piperine $C_{17}H_{19}NO_3$ in Several Solvents.
(U. S. P., VIII.)

| Solvent. | t°. | Gms. per 100 Gms. Solvent. | | |
|---|---|---|---|---|
| | | $C_{11}H_{16}N_2O_2.HCl$. | $C_{11}H_{16}N_2O_2.HNO_3$. | $C_{17}H_{19}NO_3$. |
| Water | 25 | 333 | 25 | insoluble |
| Alcohol | 25 | 4.35 | 1.66 | 6.66 |
| Alcohol | 60 | 9.09 | 6.2 | 22.7 |
| Chloroform | 25 | 0.18 | ... | 58.8 |
| Ether | 25 | ... | ... | 2.8 |

***d* CAMPHOCARBONIC ACID** $C_8H_{14}\begin{cases}\text{CH.COOH}\\ \text{CO}\end{cases}$

SOLUBILITY IN XYLOL AT 20°.1. (Bredig and Joyner, 1918.)

An excess of *d* camphocarbonic acid was shaken in a thermostat at 20°.1 with 25 cc. of xylol for 45 minutes. To 10 cc. of the clear solution 30.4 cc. of 0.5*n*NaOH were added and the mixture shaken 2 minutes, centrifuged 4 minutes and the clear caustic solution layer polarized in a 4 dm. tube. The rotation was 2.28°, corresponding to 0.1827 gm. of the acid per 10 cc. xylol solution. The average of several determinations gave 0.46 gm. $C_8H_{14}\begin{cases}\text{CH.COOH}\\ \text{CO}\end{cases}$ per 25 cc. sat. solution in xylol at 20°.1.

SOLUBILITY OF CAMPHO CARBONIC ACID IN XYLOL SOLUTIONS OF SEVERAL COMPOUNDS AT 20°. (Bredig and Joyner, 1918.)

| Base added to Xylol. | Gms. base per 25 cc. xylol. | Gms. $C_8H_{15}(CH.COOH)(CO)$ per 25 cc. sat. sol. |
|---|---|---|
| Dimethylaniline. | 0.2402 | 0.490 |
| Collidine..... | 0.0838 | 0.706 |
| » ..... | 0.2478 | 1.259 |
| Diethyl amine... | 0.0698 | 0.981 |
| » » .. | 0.0768 | 1.011 |
| » » .. | 0.1208 | 1.301 |
| » » .. | 0.1430 | 0.960 |
| Tribenzyl amine. | 0.688 | 0.515 |
| Diethyl benzyl amine.. | 0.2214 | 1.247 |
| Di iso butyl amine... | 0.1080 | 0.934 |
| » » » ... | 0.2358 | 0.624 |

| Base added to Xylol. | Gms. base per 25 cc. xylol. | Gms. $C_8H_{14}(CH.COOH)(CO)$ per 25 cc. sat. sol. |
|---|---|---|
| Tripropyl amine. | 0.1726 | 1.214 |
| α Picoline..... | 0.1738 | 0.911 |
| Piperidine..... | 0.0354 | 0.740 |
| » ..... | 0.0450 | 0.732 |
| » ..... | 0.0856 | 1.068 |
| » ..... | 0.1766 | 1.688 |
| Pyridine..... | 0.3088 | 1.30 |
| Quinaldine..... | 0.4412 | 1.035 |
| » ..... | 1.122 | 1.846 |
| Quinoline. ..... | 0.2824 | 0.916 |
| *m* Toluidine..... | 0.7784 | 1.33 |

**OCTYL MALONIC ACID** $CH(C_8H_{17})(COOH)_2$.

100 gms. $H_2O$ dissolve 0.026 gm. $CH(C_8H_{17})(COOH)_2$ (m.pt. 113°.5-115°) at 25°.
" " $C_6H_6$ " 0.0132 " " " " " "

(Verkade and Coops, Jr., 1930a.)

**ETHYL PIMELATE** $(CH_2)_5(COOC_2H_5)_2$.

100 cc $H_2O$ dissolve 0.199 gm. $(CH_2)_5(COOC_2H_5)_2$ at 20°.

(Sobotka and Kahn, 1931.)

**NONANE DICARBOXYLIC ACID** $(CH_2)_9(COOH)_2$.

100 gms. $C_6H_6$ dissolve 0.0036 gm. $(CH_2)_9(COOH)_2$ at 25°.

(Verkade and Coops, Jr., 1930.)

**FORMYL d NEOMENTHYL AMINE** $C_{10}H_{19}NHCOH$.

Freezing-point data for mixtures of d and l formyl neomenthyl amines are given by Read and Steele, 1927.

**UNDECYLIC** (Hendecanoic) **ACID** $CH_3(CH_2)_9COOH$.

Freezing-point data for mixtures of undecylic and lauric acids are given by Kulka and Sandin, 1937.

**UNDECANE** (Hendecane) $CH_3(CH_2)_9CH_3$.

The critical solution temperature of mixtures of undecane and liquid sulfur dioxide is 42° and the reciprocal solubility curve at this temperature is practically flat between 65 and 95 mol. percent $SO_2$.

(Leslie, 1934.)

**BROM UNDECAN ACIDS** $CH_2Br(CH_2)_9COOH$.

Freezing-point data for mixtures of 10- and 11-Brom undecan acids are given by Ashton and Smith, 1934.

**ETHYL PELARGONATE** $(CH_3)(CH_2)_7COOC_2H_5$.

100 cc $H_2O$ dissolve 0.003 gm. $CH_3(CH_2)_7COOC_2H_5$ at 20°.
(Sobotka and Kahn, 1931.)

**BENZINE** (Petroleum) $C_5H_{12}C_6H_{14}$.

100 parts of alcohol dissolve about 16 parts benzine of 0.638-0.660 Sp. Gr., at 25°.

**HEXA NITRO DIPHENYL AMINE** $(NO_2)_3C_6H_2NHC_6H_2(NO_2)_3$.

SOLUBILITY OF HEXANITRO DIPHENYL AMINE IN SEVERAL SOLVENTS.
(Desvergnes, 1925.)

| Solvent | Gms. $C_{12}H_5O_{12}N_7$ per 100 gms. solvent at: 17° | 50° | Solvent | Gms. $C_{12}H_5O_{12}N_7$ per 100 gms. solvent at: 17° | 50° |
|---|---|---|---|---|---|
| Water | 0.006 | 0.015 | $CHCl_3$ | 0.0 | 0.058 |
| " | — | 0.034 (100°) | $(C_2H_5)_2O$ | trace | 0.008 (34°) |
| $CH_3COOC_2H_5$ | 0.841 | 1.251 | $C_5H_5N$ | 172.25 | 485.26 (1) |
| $(CH_3)_2CO$ | 0.573 | 1.149 | $CS_2$ | 0.0 | 0.018 (35°) |
| $C_2H_5OH$ (96%) | 0.073 | 0.104 | $CCl_4$ | 0.0 | 0.062 |
| " (100%) | 0.030 | 0.117 | $C_6H_5CH_3$ | 0.131 | 0.293 |
| $C_6H_6$ | 0.0 | 0.399 | (1) Complex formation. | | |

Freezing-point data for mixtures of hexa nitro phenyl amine and tri nitro toluene are given by Giua, 1914, 1915.

**TETRA NITRO DIPHENYL AMINE** $(NO_2)_2C_6H_3NHC_6H_3(NO_2)_2$.

SOLUBILITY OF TETRANITRO DIPHENYL AMINE IN SEVERAL SOLVENTS.
(Desvergnes, 1925.)

| Solvent | Gms. $C_{12}H_7O_8N_5$ per 100 gms. solvent at: 15° | 50° | Solvent | Gms. $C_{12}H_7O_8N_5$ per 100 gms. solvent at: 15° | 50° |
|---|---|---|---|---|---|
| Water | 0.0082 (13.5°) | 0.0103 | $C_6H_6$ | 0.320 | 0.998 |
| " | — | 0.0202 (100°) | $CHCl_3$ | 0.201 | 0.478 |
| $CH_3COOC_2H_5$ | 0.100 | 0.519 | $(C_2H_5)_2O$ | 0.024 | 0.104 (35°) |
| $(CH_3)_2CO$ | 3.400 | 6.546 | $C_5H_5N$ | 6.807 | 12.472 |
| $CH_3OH$ | 0.100 | 0.519 | $CS_2$ | 0.015 | 0.033 (37°) |
| $C_2H_5OH$ (96%) | 0.040 | 0.233 | $CCl_4$ | 0.020 | 0.040 |
| " (100%) | 0.063 | 0.212 | $C_6H_5CH_3$ | 0.361 | 0.710 |

**BIPHENYL, DIBROMO and DICHLORO** $C_6H_4BrC_6H_4Br$, $C_6H_4ClC_6H_4Cl$.

Freezing-point data are given for mixtures of:

Dibromo biphenyl + Difluoro biphenyl (Roselius, 1933.)
" " + Biphenyl " "
Dichloro biphenyl + Biphenol (Grimm, Gunther and Titus, 1931.)
" " + Bitolyl " " " " "
" " + Benzidine " " " " "

**BIPHENYLENE OXIDE** (Dibenzo furan) $C_6H_4OC_6H_4$.

Freezing-point data are given by Cullinane and Plummer, 1938, for the following mixtures:

Diphenylene oxide + diphenylene sulfide
" " + " selenide
Diphenylene dioxide + diphenylene sulfide
" " + " selenide
Diphenylene sulfide + diphenylene selenide
" disulfide + " diselenide

**BIPHENYL 4-BROMO, CHLORO** etc. $C_6H_5C_6H_4Br$.

Freezing-point data are given by Klemm, Klemm and Schæmann, 1933, for mixtures of:

Bromo biphenyl + Chloro biphenyl
" " + Biphenyl
" " + Fluoro biphenyl
Chloro biphenyl + Biphenyl
" " + Fluoro biphenyl
Fluoro biphenyl + Biphenyl

**BIPHENYL p IODO** $C_6H_5C_6H_4I$.

Freezing-point data are given by Pfeiffer, Schmitz and Inoue, 1929, for mixtures of Iodo diphenyl and each of the following compounds: Dianisal acetone, dipiperonal acetone, menthol, α naphthol, α naphthylamine, piperonal aceto phenone, sarcosine anhydride, tri nitro benzene.

**BROMO** (Chloro, Iodo) **ACENAPHTHENE** $C_{10}H_5Br(CH_2)_2$.

Freezing-point data for mixtures of Bromo, Chloro and Iodo acenaphthenes are given by Crompton and Walker, 1912.

**CARBAZOLE** (Diphenylene imide) $(C_6H_4)_2NH$.

100 grams abs. alcohol dissolve 0.92 gm. $(C_6H_4)_2NH$ at 14°, and 3.88 gms. at b. pt.

100 gms. toluene dissolve 0.55 gm. $(C_6H_4)_2NH$ at 16.5°, and 5.46 gms. at b. pt.

## CARBAZOLE $(C_6H_4)_2NH$.

100 gms. abs. Alcohol dissolve 1.30 gms. $(C_6H_4)_2NH$ at 20°-25°. (Pucher and Dehn, 1921.)
» Quinoline » 33.40 » »
» Equi molecular Mixture of Alcohol and Quinoline dissolve 9.86 gms. $(C_6H_4)_2NH$ at 20°-25°. (Pucher and Dehn, 1921.)

SOLUBILITY OF CARBAZOLE IN VARIOUS ORGANIC SOLVENTS. (Clark, 1919 *a*.)

| Solvent. | *d* of solvent. | B. pt. of solvent. | Gms. $(C_6H_4)_2NH$ per 100 gms. solvent at 15°.5. | 30°. | 50°. | 80°. | 100°. |
|---|---|---|---|---|---|---|---|
| Benzene | 0.880 | 80 – 80.5 | 0.72 | 1.01 | 5.05 | – | – |
| Toluene | 0.870 | 110 –110.3 | 0.42 | 0.78 | 1.60 | 2.90 | 4.78 |
| Refined Solvent Naphtha | 0.865 | 145 –166 | 0.48 | 0.70 | 1.37 | 3.00 | 3.72 |
| Crude » | 0.893 | 152 –179 | 0.54 | 0.94 | 1.70 | 3.84 | 7.00 |
| Heavy Naphtha | 0.909 | 165 –185 | 0.48 | 0.75 | 1.52 | 3.63 | 4.70 |
| Chloroform | 1.495 | 60.4– 62.0 | – | 0.60 | 1.08 | – | – |
| Carbon disulfide | 1.270 | 45.7– 47.0 | – | 0.44 | – | – | – |
| Acetone | 0.800 | 56.0– 57.0 | 6.12 | 9.74 | 62.30 | – | – |
| Light Pyridine (1) | 0.952 | 125 –150 | 12.45 | 16.90 | 26.74 | 66.80 | – |
| Heavy Pyridine (1) | 1.057 | 202 –247 | 2.72 | 4.10 | 10.57 | 16.54 | 22.87 |
| Hydrated Pyridine (2) | 1.050 | 94 – 96 | 0.42 | 0.81 | 1.90 | 4.70 | – |
| Carbon Tetra chloride | 1.610 | 75.5– 76.5 | 0.09 | 0.11 | 0.30 | – | – |
| Gasoline | 0.742 | 90 –164 | 0.11 | 0.12 | 0.16 | – | – |
| Ether | 0.720 | 35 – 40.2 | 2.54 | 2.90 | – | – | – |

(1) These are the bases derived from coal tar oils by abstraction with $H_2SO_4$ and liberation of the base with caustic soda. They probably contain but very little pyridine.
(2) = $C_5H_5N.3H_2O$.

100 gms. sat. solution of Carbazole in liquid sulfur dioxide contain 3.0 gms. $C_{12}H_9N$ at ? t . (DeCarli, 1927.

Freezing-point data are given for mixtures of Carbazole and:

Acridine(7)
Antipyrine(9)
Anthracene(8)
" + Chrysene(8)
" + Phenanthrene(1)(6)(11)
Benzene + " (13)
Chrysene(7)(8)
Di nitro benzenes(3)
Di nitro phenol(4)
Di nitro toluene(4)
Hydroquinone(4)
Ketene(7)
Naphthols(4)
Nitro phenols(4)
Phenanthrene(1)(8)
Picric acid(4)
Pyrocatechol(4)
Pyrogallol(4)
Quinone(5)
Retene(8)
Resorcinol(4)
Sarcosine anhydride(12)
Tri nitro benzene(3)
Tri nitro toluene(2)(3)(10)

(1) Garelli, 1894; (2) Jefremow, 1927; (3) Kremann and Strzelba, 1921; (4) Kremann and Slovak, 1920; (5) Kremann, Sutter, Sitte, Strzelba and Dobotzky, 1922; (6) Kremann and Wenzig, 1917; (7) Pascal, 1914; (8) Pascal, 1921; (9) Pfeiffer and Angern, 1926; (10) Rheinboldt, Henning and Kirscheisen, 1925; (11) Ward, 1926; (12) Pfeiffer, Angern and Wang, 1927; (13) Bruni, 1898.

**THIO DI PHENYL AMINE** $NH<(C_6H_4)_2>S$.

100 gms. sat. solution of Thio diphenyl amine in liquid sulfur dioxide contain 21.0 gms. $C_6H_9NS$ at ? t°. (DeCarli, 1927.)

**CHLORO AZO BENZENE** $ClC_6H_4N{:}NC_6H_5$.

Freezing-point data are given by Grimm, Gunther and Titus, 1931, for mixtures of 4-chloro azo benzene with 4-methyl azo benzene with 4-oxy azo benzene and with 4-amino azo benzene.

**NITRO ACENAPHTHENE** $C_{10}H_5(NO_2)(CH_2)_2$.

Freezing-point data are given by Jefremow, 1918, for mixtures of nitro acenaphthene with picric acid and with styphnic acid.

**DINITRO DIPHENYL AMINE** $2,4\text{-}NO_2C_6H_4NHC_6H_4NO_2$.

SOLUBILITY OF DINITRO DIPHENYL AMINE IN SEVERAL SOLVENTS.
(Desvergnes, 1925.)

| Solvent | Gms. $C_{12}H_9O_4N_2$ per 100 gms. solvent at: 15° | 50° | Solvent | Gms. $C_{12}H_9O_4N_2$ per 100 gms. solvent at: 15° | 50° |
|---|---|---|---|---|---|
| Water | 0.0038 | 0.0084 | $C_6H_6$ | 2.118 | 6.977 |
| " | — | 0.0143(100°) | $CHCl_3$ | 5.826 | 10.641 |
| $CH_3COOC_2H_5$ | 2.319 | 6.105 | $(C_2H_5)_2O$ | 0.378 | 0.728(30°) |
| $(CH_3)_2CO$ | 3.765 | 11.600 | $C_5H_5N$ | 11.349 | 28.665 |
| $CH_3OH$ | 0.126 | 0.611 | $CS_2$ | 0.245 | 0.567(32°) |
| $C_2H_5OH$(96%) | 0.088 | 0.046 | $CCl_4$ | 0.168 | 0.653 |
| " (100%) | 1.30 | 4.79 | $C_6H_5CH_3$ | 1.919 | 6.352 |

**BIPHENYL** $C_6H_5.C_6H_5$.

100 grams absolute methyl alcohol dissolve 6.57 grams at 19.5°.
100 grams abs. ethyl alcohol dissolve 9.98 grams at 19.5°. (de Bruyn, 1892.)

## Solubility of Biphenyl in Non-Polar Solvents.

(Warner, Schieb and Svirbely, 1934.)

The determinations were made by the synthetic method.

Results for the solubility in:

### Heptane

| t° | Mol. % $C_{12}H_{10}$ in sat. sol. | t° | Mol. % $C_{12}H_{10}$ in sat. sol. |
|---|---|---|---|
| 26.5 | 14.0 | 57.5 | 72.6 |
| 35.2 | 21.6 | 59.5 | 80.3 |
| 39.9 | 27.35 | 60.5 | 80.6 |
| 43.1 | 33.5 | 61.6 | 83.6 |
| 46.7 | 40.9 | 62.5 | 85.7 |
| 49.0 | 46.8 | 64.0 | 89.2 |
| 49.1 | 47.5 | 66.0 | 93.4 |
| 55.3 | 66.5 | 68.1 | 97.2 |

### Carbon Disulfide

| t° | Mol. % $C_{12}H_{10}$ in sat. sol. |
|---|---|
| 28.4 | 40.4 |
| 36.6 | 49.8 |
| 37.7 | 51.4 |
| 38.2 | 52.0 |
| 40.7 | 55.3 |
| 44.1 | 59.5 |
| 47.6 | 63.7 |
| 51.3 | 69.4 |
| 58.3 | 81.0 |

### Dioxane

| t° | Mol. % $C_{12}H_{10}$ in sat. sol. |
|---|---|
| 26.4 | 39.8 |
| 32.4 | 45.7 |
| 39.3 | 53.5 |
| 47.3 | 63.8 |
| 53.1 | 72.5 |
| 55.0 | 75.2 |
| 57.7 | 79.8 |
| 63.4 | 89.6 |
| 67.7 | 96.9 |

### Benzene

| t° | Mol. % $C_{12}H_{10}$ in sat. sol. |
|---|---|
| 27.9 | 41.0 |
| 43.1 | 58.5 |
| 44.3 | 60.5 |
| 45.5 | 62.6 |
| 49.4 | 67.7 |
| 52.3 | 71.3 |

### Carbon Tetrachloride

| t° | Mol. % $C_{12}H_{10}$ in sat. sol. |
|---|---|
| 28.1 | 37.2 |
| 30.7 | 40.1 |
| 40.0 | 51.8 |
| 41.3 | 53.4 |
| 53.6 | 71.4 |
| 57.4 | 78.2 |
| 64.3 | 90.6 |
| 66.0 | 93.9 |

### p Dichloro Benzene

| t° | Mol. % $C_{12}H_{10}$ in sat. sol. |
|---|---|
| 27.7 (Eutec.) | 42.5 |
| 34.1 | 49.6 |
| 41.2 | 57.5 |
| 49.8 | 69.2 |
| 57.4 | 80.2 |
| 61.4 | 85.9 |
| 65.0 | 92.3 |

Freezing-point data are given for mixtures of Biphenyl +

Anthracene(13)
Antipyrine(9)
Azobenzene(1a)
Benzophenone + Diphenylamine(3)(5)
Benzene(15)
Bibenzyl + Naphthalene(6)
Bromo biphenyl(4)
Camphor(7)
Chloro biphenyl(4)
Dianisal acetone(10)
Dibromo biphenyl(12)
Dichloro benzene(8)(14)
Dichloro biphenyl(12)
Difluoro biphenyl(12)
Diphenylamine(13)
Diphenylamine + benzophenone(3)(5)
Fluoro biphenyl(4)
Naphthalene(13)(15)
" + Biphenyl(6)
Phenanthrene(13)
Picric acid(2)
Styphnic acid(2)
Trinitro benzene (1)
Triphenyl methane(13)
Urea(11)

(1) Briegleb and Schachowskey, 1932; (1a) Beck, 1904; (2) Jefremow, 1918, 1919, 1919a; (3) Jefremow and Tichomirowa, 1926; (4) Klemm, Klemm and Schiemann, 1933; (5) Lee and Warner, 1933; (6) Lee and Warner, 1935; (7) Maka and Nagai, 1933; (8) Morris and Cook, 1935; (9) Pfeiffer and Angern, 1926; (10) Pfeiffer, Schmitz and Inoue, 1929; (11) Puschin and König, 1928; (12) Roselius, 1933; (13) Vignon, 1891; (14) Warner, Schieb and Svirbely, 1934; (15) Washburn and Read, 1915.

## ACENAPHTHENE $C_{12}H_{10}$.

### Solubility in Several Organic Solvents.

(Speyers — *Am. J. Sci.* [4], **14**, 294, 1902.)

| | In Methyl Alcohol. | | | In Ethyl Alcohol. | | | In Propyl Alcohol. | | |
|---|---|---|---|---|---|---|---|---|---|
| t°. | (*a*). | (*b*). | (*c*). | (*a*). | (*b*). | (*c*). | (*a*). | (*b*). | (*c*). |
| 0... | 81.33 | 1.80 | 0.39 | 81.1 | 1.9 | 0.57 | 82.3 | 2.26 | 0.88 |
| 10... | 80.40 | 1.70 | 0.38 | 80.3 | 2.8 | 0.84 | 81.8 | 2.40 | 1.00 |
| 20... | 79.60 | 2.25 | 0.48 | 79.6 | 4.0 | 1.20 | 81.4 | 3.40 | 1.35 |
| 30... | 79.00 | 3.50 | 0.72 | 79.1 | 5.6 | 1.70 | 80.9 | 4.75 | 1.90 |
| 40... | 78.45 | 6.00 | 1.20 | 78.7 | 8.4 | 2.60 | 80.6 | 7.10 | 2.90 |
| 50.. | 78.15 | 9.00 | 1.77 | 78.8 | 13.2 | 3.90 | 80.7 | 11.10 | 4.40 |
| 60... | 78.30 | 11.70 | 2.35 | 79.4 | 23.2 | 7.00 | 81.5 | 19.60 | 8.20 |
| 70... | 78.60 | 14.30 | 2.90 | 80.75 | 40.5 | 12.50 | 83.9 | 37.00 | 16.20 |

| | In Chloroform. | | | In Toluene. | | |
|---|---|---|---|---|---|---|
| t°. | (*a*). | (*b*). | (*c*). | (*a*). | (*b*). | (*c*). |
| 0..... | 143.8 | 18.8 | 12.7 | 90.7 | 12.4 | 7.9 |
| 10..... | 140.1 | 24.0 | 16.0 | 90.8 | 15.0 | 10.7 |
| 20..... | 136.3 | 33.0 | 19.5 | 91.0 | 20.0 | 14.5 |
| 30..... | 132.4 | 45.0 | 25.0 | 91.8 | 30.0 | 20.5 |
| 40..... | 128.0 | 60.0 | 32.0 | 92.7 | 53.0 | 28.0 |
| 50..... | 123.4 | 85.0 | 40.0 | 94.0 | 85.0 | 35.7 |
| 60..... | 119.3 | 122.0 | 50.0 | 95.5 | 125.0 | 43.5 |
| 70..... | ..... | ..... | .... | 97.2 | 180.0 | 52.5 |

(*a*) Weight in grams of 100 cc. of sat. solution. (*b*) Grams of Acenaphthene dissolved per 100 grams solvent. (*c*) Gram molecules of Acenaphthene per 100 gram molecules of solution.

1000 gms. Aq. 25% $NH_3$ dissolve 0.07 gm. acenaphthene at 25°. (Hilpert, 1916).

100 gms. sat. solution of acenaphthene in liquid sulfur dioxide contain 13.0 gms. $C_{12}H_{10}$ at ? t°. (De Carli, 1927.)

Freezing-point data are given for mixtures of Acenaphthene and:

Benzil(15)
Bromo acenaphthene(14)
Cinnamylidene acetophenone(2)
Chloro acenaphthene(14)
Dianisal acetone(11)(12)
Dinitro benzene(1)(7)
Dinitro phenol(7)
Dinitro toluene(1)(7)(8)
Dinitro xylene(6)
Iodo acenaphthene(14)
Fluorenone(11)(12)
Michler's ketone(11)
Nitro phenols(7)
Picramide (3)
Picric acid(3)
Picryl chloride(3)
Quinone(10)
Nitro benzoic aldehyde(16)
Piperonilic aldehyde(16)
Vanillic aldehyde(16)
Styphnic acid(3)
Tetra methyl diamino benzophenone(12)
Tetra methyl diamino dibenzyl acetone(11)(12)
Tetryl(5)
Tetra nitro benzene(13)
" " cresol(4)
" " toluene(1)(9)
" " xylene(5)

Freezing-point data for mixtures of Nitro acenaphthene with picric acid and with styphnic acid and for mixtures of Acenaphthylene with picryl chloride and with styphnic acid are given by (3).

(1) Giua, 1915; (2) Giua, 1916; (3) Jefremow, 1918; (4) Jefremow and Tichomirowa, 1927; (5) Jefremow and Tichomirowa, 1928; (6) Hertel and Kleu, 1930; (7) Kremann and Haas, 1919; (8) Kremann, Königsberg and Mauermann, 1923; (9) Kremann and Strzelba, 1921; (10) Kremann, Sutter, Sitte, Strzelba and Dobolszky, 1922; (11) Pfeiffer, 1924; (12) Pfeiffer, Goebel and Angern, 1925; (13) Shinomiya, 1940; (14) Crompton and Walker, 1912; (15) Pawlewski, 1893; (16) Fazi, 1916.

**Dibromo PHENYL SELENIDE and TELLURIDE** $(C_6H_5)_2SeBr_2, (C_6H_5)_2TeBr_2$.

Data for the solubility of mixtures of dibromophenyl selenide and dibromophenyl telluride in benzene at 21° are given by Pellini (1906).

**AZOBENZENE** (trans) $C_6H_5N:NC_6H_5$.

SOLUBILITY OF TRANS AZOBENZENE IN AQUEOUS SOLUTIONS OF CETYL-PYRIDIUM CHLORIDE ALONE AND CONTAINING SODIUM CHLORIDE AT 25°.

(Hartley, 1938.)

Results for aqueous solutions of:

| Cetyl Pyridium Chloride Alone | | Cetyl Pyridium Chloride + NaCl | | |
|---|---|---|---|---|
| Gm. Equiv. Cetyl Pyridium Chloride per liter | Gm. Mols. trans Azobenzene per liter | Gm. Equiv. per liter: Cetyl Pyridium chloride | Gm. Equiv. per liter: Sodium chloride | Gm. Mols. trans Azobenzene per liter |
| 0.0 | 0.000024 | 0.00031 | 0.0032 | 0.000024 |
| 0.00072 | 0.000026 | 0.00104 | 0.0032 | 0.000130 |
| 0.00095 | 0.000035 | 0.00418 | 0.0032 | 0.000642 |
| 0.00104 | 0.000048 | 0.00031 | 0.010 | 0.00047 |
| 0.00119 | 0.000070 | 0.00104 | 0.010 | 0.00163 |
| 0.00180 | 0.000175 | 0.00418 | 0.010 | 0.00671 |
| 0.00238 | 0.000268 | 0.00031 | 0.032 | 0.000062 |
| 0.00418 | 0.000554 | 0.00104 | 0.032 | 0.000178 |
| 0.00714 | 0.00103 | 0.00418 | 0.032 | 0.000683 |
| 0.0143 | 0.00219 | 0.000 | 0.10 | 0.000020 |
| 0.0209 | 0.00326 | 0.00031 | 0.10 | 0.000069 |
| 0.0314 | 0.00502 | 0.00104 | 0.10 | 0.000189 |
| 0.0500 | 0.00816 | 0.00418 | 0.10 | 0.000710 |
| 0.1045 | 0.0178 | 0.00031 | 0.32 | 0.000075 |
| 0.2080 | 0.0374 | 0.00104 | 0.32 | 0.000206 |
| 0.3120 | 0.0586 | 0.00418 | 0.32 | 0.000788 |
| 0.4980 | 0.1000 | | | |

Similar results are also given for the solubility of trans azo benzene in cetyl pyridium acetate and sulfate at 25° and in aqueous solutions of the bromide and chloride at 33°.

SOLUBILITY OF TRANS AZOBENZENE IN AQUEOUS SOLUTIONS OF ACETONE AT 25°.

(Hartley, 1938.)

| Gms. per 100 gms. sat. sol. | | | Gms. per 100 gms. sat. sol. | | |
|---|---|---|---|---|---|
| $(CH_3)_2CO$ | $H_2O$ | $C_{12}H_{10}N_2$ | $(CH_3)_2CO$ | $H_2O$ | $C_{12}H_{10}N_2$ |
| 54.7 | 0.0 | 45.3 | 20.4 | 79.6 | 0.0097 |
| 67.8 | 17.5 | 14.7 | 12.0 | 88.0 | 0.0026 |
| 60.1 | 36.3 | 3.58 | 0.0 | 100.0 | 0.00044 |
| 42.2 | 57.3 | 0.28 | | | |

### Solubility of Azobenzene in Several Alcohols.
(Timofeiew, 1894.)

| Solvent. | t°. | Gms. $(C_6H_5N)_2$ per 100 Gms. Sat. Sol. | Solvent. | t°. | Gms. $(C_6H_5N)_2$ per 100 Gms. Sat. Sol. |
|---|---|---|---|---|---|
| Methyl Alcohol | 9.5 | 3.8 | Ethyl Alcohol | 10.5 | 5.88 |
| " " | 10.5 | 3.95 | Propyl Alcohol | 9.5 | 5.42 |
| Ethyl Alcohol | 9.5 | 5.29 | " " | 10.5 | 6.02 |

### Solubility of Azobenzenes in Water and in Pyridine.
(Dehn, 1917.)

| Solvent. | t°. | Gms. Each Compound (Determined Separately) per 100 Gms. Solvent: Azobenzene. | Diazoamino-benzene. | Dimethylamino-azobenzene. |
|---|---|---|---|---|
| Water | 20–25 | 0.03 | 0.05 | 0.016 |
| Pyridine | 20–25 | 76.44 | 136.7 | 27.90 |
| Aq. 50% Pyridine | 20–25 | 16.78 | 67.7 | 4.51 |

### Solubility of Azobenzene in Several Solvents at 25°.
(Hartley, 1938.)

| Solvent | Gms. $C_{12}H_{10}N_2$ per 100 gms. sat. sol. | Solvent | Gms. $C_{12}H_{10}N_2$ per 100 gms. sat. sol. |
|---|---|---|---|
| Benzene | 35.0(1) | n Decane | 15.6 |
| Pyridine | 50.9 | n Hexadecane | 12.2 |

(1) Solid phase $(C_6H_5N)_2.C_6H_6$

### Solubility of Azobenzene in Several Solvents.

| Solvent. | t°. | Gms. $C_6H_5.N_2.C_6H_5$ per 100 gms. solvent. | Authority. |
|---|---|---|---|
| Amyl acetate..... | 25 | 44.1 | (Kröber, 1919.) |
| Methyl butyrate..... | 25 | 62.2 | » |
| Methyl formate..... | 25 | 46.6 | » |
| Carbon tetrachloride..... | 20 | 2.83 | (Pawlewski, 1914.) |
| Chloroform..... | 20 | 16.24 | » |
| Ethyl alcohol (abs.)..... | 20–25 | 9.25 | (Pucher and Dehn, 1921.) |
| Equi. mol. Mixture of Ethyl alcohol+Quinoline. | 20–25 | 22.9 | » |

### Solubility of Azobenzene in Rubber. (Bruni, 1921.)

Mixtures of azobenzene and rubber were heated untill homogeneous and then cooled to incipient crystallization.

| t° of cryst. | Gms. $C_6H_5N_2C_6H_5$ per 100 gms. mixture. | t° of cryst. | Gms. $C_6H_5N_2C_6H_5$ per 100 gms. mixture. | t° of cryst. | Gms $C_6H_5N_2C_6H_5$ per 100 gms. mixture. |
|---|---|---|---|---|---|
| 69.0..... | 100.0 | 67.2..... | 80.0 | 59.2..... | 50.0 |
| 68.95..... | 98.0 | 66.2..... | 75.0 | 52.1..... | 40.0 |
| 68.6..... | 95.0 | 65.7..... | 70.0 | 43.4..... | 30.0 |
| 68.6..... | 90.0 | 63.1..... | 60.0 | | |

Data for the distribution of azobenzene between hexane and methylalcohol are given by Perschke, 1926.

Freezing-point data are given for mixtures of Azobenzene and:

Acetic acid(2)(13)
Azo naphthalene(15)
Azo toluene(15)
Azoxybenzene(9)
Benzal aniline(15)
Benzene azonaphthalene(1)
Benzoic acid(13)
Benzil(17)(18)
Benzoin(18)
Benzylaniline(1)(10)(11)(12)(15)
Cinnamic acid(13)
Cinnamylidine acetophenone(5)
Dibenzyl(3)(8)(10)(15)
Dinitro benzene(7)
Dinitro toluene(7)
Dichlor acetic acid(13)
Dinitro phenol(4)
Dimethoxy stilbene(15)
Diphenyl(1)
Diphenyl amine(6)
Hydroquinone(14)
Naphthols(14)
Naphthylamine(16)
Nitro phenols(14)
Nitro toluene(7)
Pyrocatechol(14)
Pyrogallol(14)
Picric acid(14)
Resorcinol(14)
Salicylic acid(13)
Stilbene(1)(15)
Succinic acid(13)
Tolane(15)
Toluylic acid(16)
Tri chlor acetic acid(13)
Trinitro toluene(7)

(1) Beck, 1904; (2) Bradley and Marsh, 1933; (3) Bruni and Gorni, 1899; (4) Erlenmeyer and Leo, 1933; (5) Giua, 1916; (6) Giua and Cherchi, 1919; (7) Giua and Reggiani, 1925; (8) Garelli and Calzolari, 1899; (9) Hartley and Stewart, 1914; (10) Hasselblatt, 1913; (11) Isaac, 1910-11; (12) Jaeger, 1907; (13) Kremann and Zechner, 1925; (14) Kremann, Zechner and Weber, 1924; (15) Pascal and Normand, 1913; (16) Pfeiffer, Angern, Wang, Seydel and Quehl, 1930; (17) Tammann and Botschwar, 1926; Vanstone, 1913.

**CHLORO DIPHENYL AMINE** p $ClC_6H_4NHC_6H_5$.

Freezing-point data are given by Chapman and Perrott, 1930, for mixtures of p chloro diphenyl amine with diphenyl amine and with di-p-chloro phenyl amine.

**DI PHENYL DI SULFIDE** $(C_6H_5)_2S_2$.

Freezing-point data are given by Grimm, Gunther and Titus, 1931, for mixtures of diphenyl disulfide and dibenzyl. Results for mixtures of diphenyl sulfide, selenide, telluride and diphenyl ether are given by Pascal, 1912.

**PHENYL ETHER** $(C_6H_5)_2O$.

The critical solution temperature of a mixture of phenyl ether and iso amyl benzoate is 23.5°. (Lecat, 1928.)

Freezing-point data for mixtures of phenyl ether with diphenyl methane and with diphenyl amine are given by Grimm, Gunther and Titus, 1931.

Results for mixtures of Phenyl ether and tri nitro benzene are given by Sudborough and Beard, 1911.

Hydroxy**AZOBENZENE** $C_6H_5.N:N.C_6H_4OH$.

1000 cc. sat. solution in $H_2O$ contain 0.0225 gm. $C_6H_5N:N.C_6H_4OH$ at 25°.

1000 cc. sat. solution in $H_2O$ sat. with $C_6H_6$ contain 0.0284 gm. $C_6H_5N:N.C_6H_4OH$ at 25°.

1000 cc. sat. solution in $C_6H_6$ sat. with $H_2O$ contain 15.20 gms. $C_6H_5N:N.C_6H_4OH$ at 25°. (Farmer, 1901)

Distribution results for hydroxyazobenzene between benzene and water gave: conc. in $C_6H_6$ ÷ conc. in $H_2O$ = 539 at 25°. (Farmer, 1901.)

Freezing-point data for mixtures of oxyazobenzene with amino azobenzene and with chloro azobenzene are given by Grimm, Gunther and Titus, 1931.

**AZOXY BENZENE** $C_6H_5(NON)C_6H_5$.

Freezing-point data for mixtures of azoxy benzene with bromo dinitro benzene, with dinitro toluene and with trinitro toluenes are given by Giuà and Guastella, 1925.

**BIPHENOL** $HOC_6H_4.C_6H_4OH$.

Freezing-point data for mixtures of biphenol with benzidine with di tolyl and with dichloro diphenyl are given by Grimm, Gunther and Titus, 1931.

**NAPHTHYL ACETATE** $CH_3COOC_{10}H_7$.

Freezing-point data are given for

α and β Naphthyl acetates + Acetic acid (Kendall and Booge, 1916.)
β Naphthyl acetate + Picric acid (Shinomiya, 1940.)
" " + Tri nitro benzene " "
" " + Tetra nitro benzene" "

**METHYL NAPHTHOATE** β $C_{10}H_7COOCH_3$.

Freezing-point data are given by Shimomiya, 1940 for mixtures of β methyl naphthoate with picric acid with trinitro benzene and with tetra nitro benzene.

**BENZOIC ANHYDRIDE** $(C_6H_5CO)_2O$.

Freezing-point data are given for mixtures of benzoic anhydride and sulfuric acid by Kendall and Carpenter (1914).

**METHYL ORANGE** $H_2NC_6H_4.N_2.C_6H_4SO_3Na$.

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 100 gms. | $H_2O$ | dissolve | 0.02 | gm. | methyl orange | at | 20–25°. | (Dehn, 1917.) |
| " | pyridine | " | 1.80 | " | " | " | " | |
| " | aq. 50% pyridine | " | 51.5 | " | " | " | " | |

**QUINHYDRONE** $C_6H_4O_2, C_6H_4(OH)_2$.

Solubility of Different Samples of Quinhydrone in 0.01 Normal Hydrochloric Acid at 18°. (Sörensen, Sörensen and Linderstrom-Lang, 1921.)

The samples were prepared by mixing alcoholic solutions of definite molecular amounts of the two constituents of the compound. The resulting precipitates were filtered, washed with alcohol and rapidly dried. The saturated solutions were prepared by constant agitation for periods of 4 to 19 hours.

| Sample N°. | Mols. per liter | |
|---|---|---|
| | Quinhydrone. | Hydroquinone. |
| UKL I.... | 0.01426 | 0.01418 |
| UKL II... | 0.01371 | 0.01392 |
| CL I..... | 0.01276 | 0.01267 |
| CL I*a*. ... | 0.01297 | 0.01293 |

| Sample N°. | Mols. per liter | |
|---|---|---|
| | Quinhydrone. | Hydroquinone. |
| CL II..... | 0.01301 | 0.01302 |
| CL III..... | 0.01302 | 0.01309 |
| CL IV..... | 0.01298 | 0.01307 |

**QUINHYDRONE** $C_6H_4O_2.C_6H_4(OH)_2$.

Data for the solubility and dissociation of quinhydrone in water at 25° are given by Luther and Leubner, 1912. Later experiments at 15°, 25° and 35° are reported by Berthoud and Kunz, 1938. These latter authors describe the difficulties of reaching equilibrium, both from above and from below, and found it necessary to use 0.001 n HCl as solvent instead of water in order to avoid persistant colloidal opalescence in the solutions. They give the following results for the solubility of quinhydrone in water (0.001 n HCl) and in aqueous solutions of hydroquinone.

| Gm. Mol. Hydroquinone per liter aq. solvent | Gm. Mol. Quinhydrone per liter sat. sol. at: 15° | 25° | 35° |
|---|---|---|---|
| 0.0(= 0.001 n HCl) | 0.01224 | 0.01870 | 0.02788 |
| 0.00781 | 0.00893 | — | — |
| 0.01562 | 0.00675 | 0.01271 | 0.02154 |
| 0.03125 | 0.00447 | 0.00945 | 0.01711 |
| 0.0625 | 0.00273 | 0.00606 | 0.01160 |
| 0.125 | 0.00160 | 0.003775 | 0.00737 |
| 0.250 | — | 0.002425 | 0.00496 |

The solubility of Quinhydrone in aq. 0.01 n $H_2SO_4$ is 0.0181 gm. mol. per liter at 25°.

The solubility of Thymoquinhydrone in aq. 0.01 n HCl+0.09 nKCl is 0.00276 gm. mol. per liter at 25°. (Biilmann and Muus, 1931.)

One liter sat. solution of quinhydrone in water contains 0.0158 gm. mol. $C_{12}H_{10}O_4$ at 20°. (Brodsky and Alfero, 1929.)

SOLUBILITY OF QUINHYDRONE IN AQUEOUS ETHYL ALCOHOL AT 20°.
(Brodsky and Alfero, 1929.)

| Wt. % $C_2H_5OH$ in aq. solvent | Gm. Mols. $C_{12}O_{10}O_4$ per liter sat. sol. |
|---|---|
| 25.55 | 0.0330 |
| 49.81 | 0.0684 |
| 71.31 | 0.1158 |

**DIPHENYLAMINE** $(C_6H_5)_2NH$.

RECIPROCAL SOLUBILITY OF DIPHENYLAMINE AND WATER, BY SYNTHETIC METHOD.
(Campetti and del Grosso, 1913.)

| t°. | Gms. $(C_6H_5)_2$ NH per 100 Gms. Mixture. | t°. | Gms. $(C_6H_5)_2NH$ per 100 Gms. Mixture. | t°. | Gms. $(C_6H_5)_2NH$ per 100 Gms. Mixture. |
|---|---|---|---|---|---|
| 231 | 1.48 | 305 crit. t. | 47.5 | 239 | 88.28 |
| 264 | 3.49 | 304 | 62.52 | 229 | 90.23 |
| 275 | 5.62 | 299 | 73.07 | 210 | 92.93 |
| 297 | 16.50 | 289 | 82.08 | 152 | 97.19 |
| 303 | 45.16 | 249 | 86.73 | | |

Similar data for the systems diphenylamine + ether and diphenylamine + isopentane are given by Campetti, 1917.

## Solubility of Diphenylamine in Water.

(Desvergnes, 1928.)

| t° | Gms. $(C_6H_5)_2NH$ per 100 gms. $H_2O$ |
|---|---|
| 0 | 0.003 |
| 15 | 0.00316(1) |
| 28 | 0.007 |
| 50 | 0.012 |
| 85 | 0.032 |

(1) Thiel, 1929.

## Solubility of Diphenylamine in Aqueous Ethyl Alcohol.

(Desvergnes, 1928.)

| Vol. % Aq. $C_2H_5OH$ | $d_{15}$ of Aq. $C_2H_5OH$ | Gms. $(C_6H_5)_2NH$ per 100 gms. aq. $C_2H_5OH$ at: 0° | 28° | 40° |
|---|---|---|---|---|
| 29.9 | 0.9696 | 0.003 | 0.005 | 0.007 |
| 38.9 | 0.9532 | 0.007 | 0.089 | 0.22 |
| 52.4 | 0.9313 | 0.213 | 0.761 | 1.24 |
| 68.6 | 0.8939 | 1.395 | 5.025 | 7.63 |
| 77.1 | 0.8724 | 2.477 | 8.764 | 15.55 |
| 87.1 | 0.8430 | 6.510 | 23.054 | 109.61 |
| 92.0 | 0.8272 | 9.825 | 38.621 | 223.29 |
| 96.2 | 0.8112 | 14.545 | 64.207 | 317.20 |
| 100.0 | 0.7914 | 26.269 | 95.842 | 385.83 |

## Solubility of Diphenyl Amine in Various Solvents.

(Desvergnes, 1928.)

| Solvent | $d_{15}$ of solvent | Gms. $C_6H_5NH$ per 100 gms. solvent at: 0° | 28° | 40° | Color of solution |
|---|---|---|---|---|---|
| Ethyl acetate | 0.9048 | 135.218 | 306.79 | — | pale amber |
| Acetone | 0.7998 | 239.830 | 298.59 | — | pale yellow |
| Methyl alcohol | 0.8055 | 26.708 | 122.98 | 516.55 | pale amber |
| Benzene | 0.8826 | 110.674 | 277.99 | 416.67 | " " |
| Chloroform | 1.4887 | 86.545 | 206.26 | — | wine red |
| Anhydrous ether | 0.7193 | 140.576 | 324.79 | — | pale amber |
| Pyridine | 0.9805 | 217.626 | 306.91 | 425.62 | " " |
| Carbon disulfide | 1.2723 | 112.452 | 314.12 | — | " " |
| Carbon tetra chloride | 1.6012 | 27.734 | 122.63 | — | dark violet |
| Toluene | 0.8733 | 85.794 | 227.65 | 315.72 | pale amber |
| m Xylene | 0.8683 | 49.976 | 163.14 | 247.85 | " " |

## Solubility of Diphenylamine in Several Solvents.

| Solvent. | t°. | Gms. $(C_6H_5)_2NH$ per 100 Gms. Solvent. | Authority. |
|---|---|---|---|
| Water | 20–25 | 0.03 | (Dehn, 1917.) |
| Methyl Alcohol | 14.5 | 45.2 | (Timofeiew, 1894.) |
| " " | 19.5 | 57.5 | (de Bruyn, 1892.) |
| Ethyl Alcohol | 14.5 | 39.4 | (Timofeiew, 1894.) |
| " " | 19.5 | 56 | (de Bruyn, 1892.) |
| Propyl Alcohol | 14.5 | 29.4 | (Timofeiew, 1894.) |
| Pyridine | 20–25 | 302 | (Dehn, 1917.) |
| Aq. 50% Pyridine | 20–25 | two layers formed | " |

## Solubility of Diphenylamine in Hexane and in Carbon Disulfide.

(Etard, 1894.)

| t°. | Gms. $NH(C_6H_5)_2$ per 100 Gms. Sol. in: | | t°. | Gms. $NH(C_6H_5)_2$ per 100 Gms. Sol. in: | |
|---|---|---|---|---|---|
| | Hexane. | $CS_2$. | | Hexane. | $CS_2$. |
| −60 | ... | 1.3 | 0 | 2.6 | 33.7 |
| −50 | ... | 2.2 | +10 | 3.8 | 46.8 |
| −40 | ... | 3.8 | 20 | 6.7 | 60.9 |
| −30 | 0.5 | 7.2 | 30 | 13.8 | 76 |
| −20 | 0.8 | 12.5 | 40 | 47 | ... |
| −10 | 1.4 | 21.6 | 50 | 94 | ... |

Freezing-point data are given for mixtures of Diphenyl amine and:

Acetanilide(13)
Acetyl diphenyl amine(4)
Antipyrine(20)
Arsenic trichloride(28)
Azobenzene(10)
Benzoic acid(2)
Benzene(5a)(6)
Benzophenone(10)
" + diphenyl(8)(18)
Camphor(31)
Cetyl alcohol(10)
Chloro dihydro phenarsazine(28)
Chloro nitro benzene(32)
Cinnamylidene aceto phenone(9)
Cresols(24)
Dichlor aniline(10)
Diethyl diphenyl urea(11)
Dinitro benzene(8)
" phenols(16)
" toluene(8)(30)
Diphenyl methane(7)
" ether(7)
Diphenyl(18)
" + benzo phenone(18)
Ethylene bromide(6)
Guaiacol(26)
Hydroquinone(16)
Naphthols(35)(16)
Naphthalene(29)(35)
Naphthylamine(35)
Nitro anisole(23)
Nitro naphthalene(5)(3)
Nitro phenols(16)(10)
Nitro penta erythritol (33)
Nitro toluene(8)
Paraffine(21)
Phenanthrene(19)
Phenol(22)
Picric acid(10)(16)
Piperonal(27)
Phenyl dimethyl pyrazolon(20)
Pyrocatechol(16)
Pyrogallol(16)
Quinone(17)
Resorcinol(16)(35)(14)
" + Urea(14)
Sarcosine anhydride(20)
Trichlor acetic acid(15)
" phenol(10)
Trimethyl trinitramine(34)
Trinitro phenol(10)
Trinitro phenoxy propionic acid ethyl ester(12)
Trinitro toluene(8)
Urea(14)(19a)
" + resorcinol(14)
Urethan(1)(23a)(25)

(1) Angeletti, 1928; (2) Baskov, 1918; (3) Battelli and Martinelli, 1885; (4) Boesken, 1912; (5) Bernoulli and Veillon, 1932; (5a) Bruni, 1898; (6) Dahms, 1895; (7) Grimm, Gunther and Titus, 1931; (8) Giua, 1915; (9) Giua, 1917; (10) Giua and Cherchi, 1919; (11) Giua and Guastella, 1933; (12) Hertel and Römer, 1930; (13) Hrynakowski and Adamanis, 1933a; (14) Hrynakowski, Stazewski and Szmyt, 1937; (15) Kitran, 1924; (16) Kremann and Schadinger, 1911; (17) Kremann, Sutter, Sitte, Strzelba and Dobotzsky, 1922; (18) Lee and Warner, 1933; (19) Narbutt, 1905; (19a) Nijveld, 1934; (20) Pfeiffer and Angern, 1926; (21) Palazzo and Battelli, 1883; (22) Philip, 1903; (23) Puschin, 1926b; (23a) Puschin, 1929; (24) Puschin and Basara, 1927; (25) Puschin and Grebinschikov, 1913, 1925; (26) Puschin and Vaic, 1926; (27) Puschin and Zivadinovic, 1933; (28) Puschin and Hraistanovic, 1938; (29) Roloff, 1895; (30) Rheinboldt, 1926; (31) Sswetlow, 1933; (32) Tinkler, 1913; (33) Urbanski, 1934; (34) Urbanski and Rabek-Gawronska, 1934; (35) Vignon, 1891.

Freezing-point data are also given for

Diphenyl methyl amine + phenol (Bramley, 1916.)
" " " + chloro phenol (Bramley, 1916.)
Hexa nitro diphenyl amine + trinitro toluene (Giua, 1915.)

Solubility of Diphenylamine and also of Triphenylamine in Carbon Disulfide. (Aretowski, 1895.)

| $NH(C_6H_5)_2$ in $CS_2$ | | $N(C_6H_5)_3$ in $CS_2$. | |
|---|---|---|---|
| t°. | Gms. per 100 Gms. Solution. | t°. | Gms. per 100 Gms. Solution. |
| $-88\frac{1}{2}$ | 0.87 | −83 | 1.91 |
| −117 | 0.37 | −91 | 1.56 |
| | | −102 | 1.24 |
| | | $-113\frac{1}{2}$ | 0.98 |

**DIPHENYLAMINE BLUE.**

Solubility in Several Solvents at 23°.
(Szathmary de Szachinar, 1910.)

| Solvent. | Gms. Diphenylamine Blue per 100 Gms. Sat. Sol. | Solvent. | Gms. Diphenylamine Blue per 100 Gms. Sat. Sol. |
|---|---|---|---|
| Methyl Alcohol | 0.385 | Acetone | 0.177 |
| Ethyl " | 0.230 | Aniline | 0.395 |
| Amyl " | 0.049 | | |

Amino**AZOBENZENE** $C_6H_5N:N.C_6H_4.NH_2$.

Distribution results for amino azobenzene between benzene and water gave: conc. in $C_6H_5$ ÷ conc. in $H_2O$ = 3,173 at 25°. (Farmer and Warth, 1904.)

Freezing-point data for mixtures of p Amino Azobenzene and:

Amino benzo phenone(1)
Azoxybenzene(3)
Chlor azo benzene(4)
Dimethyl p amino azobenzene(3)
Dinitro benzene(3)
Nitro chloro benzene(3)
Nitro toluene(3)
Oxy azo benzene(4)
Tri nitro toluene(2)

(1) Erlenmeyer and Leo, 1937, (2) Giua and Angeletti, 1921; (3) Giua and Reggiani, 1925; (4) Grimm, Gunther and Titus, 1931.

α **ACETNAPHTHALIDE** $C_2H_3ONH(C_{10}H_7)$.

Solubility in Mixtures of Alcohol and Water at 25°.
(Holleman and Antusch — Rec. trav. chim. 13, 289, 1894.)

| Vol. % Alcohol. | Gms. per 100 Gms. Solvent. | Sp. Gr. of Solutions. | Vol. % Alcohol. | Gms. per 100 Gms. Solvent. | Sp. Gr. of Solutions. |
|---|---|---|---|---|---|
| 100 | 4.02 | 0.7916 | 65 | 1.78 | 0.8977 |
| 95 | 4.31 | 0.8150 | 60 | 1.44 | 0.9091 |
| 90 | 4.11 | 0.8344 | 55 | 1.02 | 0.9201 |
| 85 | 3.69 | 0.8485 | 50 | 0.71 | 0.9290 |
| 80 | 3.18 | 0.8624 | 35 | 0.25 | 0.9537 |
| 75 | 2.73 | 0.8761 | 20 | 0.09 | 0.9717 |
| 70 | 2.31 | 0.8798 | 10 | 0.04 | 0.9841 |

Constant agitation was not employed. The mixtures were allowed to stand in bath and the solutions analyzed after different lengths of time. Formulas are not given. This applies to all determinations by Holleman and Antush.

## HYDRAZO BENZENE $C_6H_5NH:NHC_6H_5$.

Freezing-point data for mixtures of hydrazobenzene with dibenzyl and with benzal aniline are given by Pascal and Normand, 1913.

Results for mixtures of hydrazo benzene and benzoin are given by Vanstone, 1913.

## BENZIDINE $NH_2.C_6H_4.C_6H_4.NH_2$.

100 gms. abs. Ethyl Alcohol dissolve 7.68 gms. Benzidine at 20-25°. (Pucher and Dehn, 1921.)
100 gms. Quinoline » 43.07 » » » »
100 gms. Equi. Mol. Mixture of $C_2H_5OH$ and Quinoline dissolve 47.23 gms. Benzidine at 20-25° (Pucher and Dehn, 1921.)

Freezing-point data are given for mixtures of benzidine and:

Dichloro biphenyl (Grimm, Gunther and Titus, 1931.)
Diphenol " " " "
Ditolyl " " " "
Michler's ketone (Pfeiffer, 1924.)
Tetra methyl diamino benzo phenone (Pfeiffer, Goebel and Angern, 1925.)

## BENZIDINE HYDROCHLORIDE $NH_2.C_6H_4.C_6H_3NH_2.HCl$

### Solubility of Benzidine Hydrochloride in Aqueous Solutions of Hydrochloric Acid at 25°.

(Meldrum and Newlin, 1929.)

| Normality of Aq. HCl | Gms. $C_{12}H_{11}N_2.HCl$ per 1000 gms. sat. solution |
|---|---|
| 0.0 (= $H_2O$) | 5.346 |
| 2.884 | 2.172 |
| 5.607 | 1.246 |
| 9.870 | 1.224 |

## BENZIDINE SULFATE $NH_2:C_6H_4.C_6H_3.NH_2SO_3H$.

### Solubility of Benzidine Sulfate in Water. (Bisson and Christie, 1920.)

| t..... | 0°. | 25°. | 50°. | 80°. |
|---|---|---|---|---|
| Gms. Benzidine Sulfate per liter..... | 0.049 | 0.098 | 0.141 | 0.290 |

### Solubility of Benzidine Sulfate in Aqueous Solutions of Hydrochloric Acid at 25°

(Meldrum and Newlin, 1929.)

| Normality of Aq. HCl | Gms. $C_{12}H_{12}N_2.H_2SO_4$ per 1000 gms. sat. sol. | Normality of Aq. HCl | Gms. $C_{12}H_{12}N_2.H_2SO_4$ per 1000 gms. sat. sol. |
|---|---|---|---|
| 0.0 (= $H_2O$) | 0.098 | 4.139 | 1.887 |
| 0.239 | 0.542 | 5.622 | 1.774 |
| 0.530 | 0.942 | 7.601 | 1.544 |
| 1.009 | 1.253 | 9.942 | 1.499 |
| 2.074 | 1.790 | 11.099 | 1.490 |
| 2.825 | 1.930 | | |

**BENZIDINE HELIANTHATE**

1000 cc. $H_2O$ dissolve 0.245 gms. of the salt at 20-25° (Stark and Dehn, 1918.)

**NEROLIN** $C_{10}H_7OC_2H_5$.

Freezing-point data for mixtures of nerolin with dianisal acetone, with tetra methyl diamino dibenzyl acetone and with tetra methyl p diamino benzo phenone (Michler's ketone) are given by Pfeiffer, Goebel and Angern, 1925. Results for mixtures of β Naphthol ethyl ether and cinnamylidene acetophenone are given by Giua, 1916.

**PHENO BARBITAL** (Phenyl ethyl barbituric acid, Luminal) $NHCONHCOC(C_2H_5)C_6H_5CO$.

Freezing-point data are given by Pfeiffer and Seydel, 1928, for mixtures of pheno barbital with antipyrine, with dimethyl amino antipyrine, with pyramidon and with sarcosine anhydride.

**PIPERONYLIDENE DIACETATE** $CH_2O_2C_6H_3CH(OCOCH_3)_2$

Freezing-point data are given by Jorissen and van der Beek, 1924, for mixtures of piperonylidene diacetate with acetic anhydride and with piperonal.

**ANILINE m NITRO BENZENE MONO SULFONATE** etc $C_6H_5NH_2.NO_2C_6H_4SO_3H$.

SOLUBILITY OF ARYLAMINE SALTS OF NITROBENZENE MONO SULFONIC ACID, EACH SEPARATELY, IN WATER.
(Keyworth, 1927.)

| Compound | Formula | m.pt. | t° | Gms. Compound per 100 gms. sat. sol. |
|---|---|---|---|---|
| m Nitro benzene Sulfonate of: | | | | |
| Aniline | $C_6H_5NH_2.NO_2C_6H_4SO_3H$ | 222 | 20 | 1.51 |
| o Toluidine | $C_6H_4CH_3NH_2$. " | 193 | 15 | 1.93 |
| m " | " " | 195 | 15 | 1.40 |
| p " | " " | 222 | 22 | 0.83 |
| α Naphthylamine | $C_{10}H_7NH_2$. " | 221 | 17 | 0.55 |
| β " | " " | 250 | 20 | 0.27 |
| Benzidine | $(C_6H_4NH_2)_2$. " | 300+ | 15 | 0.15 |
| Tolidine | $[NH_2CH_3C_6H_3].2NO_2C_6H_4SO_3H$ | 300+ | 21 | 0.25 |
| Di anisidine | $(CH_3OC_6H_4NH_2)_2.NO_2C_6H_4SO_3H$ | 280 | 11 | 0.66 |
| m Xylidine | $(CH_3)_2C_6H_3NH_2$. " | 185 | 15 | 0.72 |
| o Chloro aniline | $ClC_6H_4NH_2$. " | 204 | 15 | 1.35 |
| p " " | " " | 234 | 17 | 1.19 |

## ANILINE BENZENE MONO SULFONATE etc. $C_6H_5NH_2.C_6H_5SO_3H$

### Solubility of Arylamine Salts of Benzene Mono Sulfonic Acid, Each Separately, in Water.

(Keyworth, 1924.)

| Compound | Formula | m. pt. | t° | Gms. Compound per 100 gms. sat. sol. |
|---|---|---|---|---|
| Benzene Mono Sulfonate of: | | | | |
| Aniline | $C_6H_5NH_2.C_6H_5SO_3H$ | 240 | 19 | 11.3 |
| o Toluidine | $C_6H_4CH_3NH_2.C_6H_5SO_3H$ | 176 | 19 | 20.0 |
| m " | " " | 173 | 18 | 9.1 |
| p " | " " | 205 | 16 | 7.4 |
| α Naphthylamine | $C_{10}H_7NH_2.C_6H_5SO_3H$ | 234 | 14 | 0.77 |
| β " | " " | 248 | 14 | 0.59 |
| p Nitro toluidine | $NO_2C_6H_3CH_3NH_2.C_6H_5SO_3H$ | 222 | 15 | 1.84 |
| m Nitro aniline | $NO_2C_6H_5NH_2.C_6H_5SO_3H$ | 236 | 15 | 3.85 |
| m Xylidene | $(CH_3)_2C_6H_3NH_2.C_6H_5SO_3H$ | 233 | 15 | 1.46 |
| Benzidine | $(C_6H_4NH_2)_2.C_6H_5SO_3H$ | 330+ | 16 | 0.59 |
| o Tolidine | $[NH_2(CH_3)C_6H_3]_2.2C_6H_5SO_3H$ | 310 | 15 | 1.45 |
| Di anisidine | $(CH_3OC_6H_4NH_2)_2.C_6H_5SO_3H$ | 277 | 18 | 2.11 |
| m Phenylene diamine | $C_6H_4(NH_2)_2.2C_6H_5SO_3H$ | 320+ | 17 | 19.0 |
| p " " | " " | 320+ | 10 | 2.57 |
| p Chloro aniline | $ClC_6H_4NH_2.C_6H_5SO_3H$ | 235 | 20 | 2.51 |
| o " " | " " | 204 | — | — |
| Ψ Cumidine | $(CH_3)_2CHC_6H_4NH_2.C_6H_5SO_3H$ | 217 | 16 | 2.03 |
| p Anisidine | $CH_3OC_6H_4NH_2.C_6H_5SO_3H$ | 182 | 16 | 12.8 |
| p Phenetidine | $C_2H_5OC_6H_4NH_2.C_6H_5SO_3H$ | 171 | 17 | 21.0 |

Results similar to the above for Arylamine Salts of α Naphthol,4, Sulfonic acid (Nevile and Winther's acid) and for Arylamine Salts of Acetyl amino naphthalene,4,sulfonic acid, using, however, as solvent aq. 1% acetic acid instead of water, are given by Forster and Watson, 1927.

Results for the solubility in water of Arylamine salts of α Naphthol,2, sulfonic acid (Schäffer's α acid, m. pt. 125°), of Crocein, of Crocein R and of Crocein G, are given by Forster and Keyworth, 1927.

## N-DIMETHYL β NAPHTHYLAMINE $C_{10}H_7N(CH_3)_2$.

Freezing-point data for mixtures of N, Dimethyl β naphthylamine and 2,4,6 trinitro anisole are given by Hertel and van Cleef, 1928.

## PHENOLATE of Phenyl Ammonium. $C_6H_5OH.C_6H_5NH_2$

### Solubility in Water.

(Alexejew, 1886.)

The determinations were made by the synthetic method (see p.292). The results were plotted and the following figures read from the curve:

| t° | Gms. Phenolate per 100 Gms. Aq. Layer. | Gms. Phenolate per 100 Gms. Phenolate Layer. |
|---|---|---|
| 10 | 3 | 94 |
| 30 | 4 | 93 |
| 50 | 5 | 91 |
| 70 | 6 | 87·5 |
| 90 | 7 | 83 |
| 110 | 9 | 76 |
| 120 | 12 | 69 |
| 130 | 17·5 | 60 |
| 140 crit. temp. | 40 | |

**TETRA METHYL PHTHALAN** $C_{12}H_{16}O$.

Freezing-point data for mixtures of tetra methyl phthalan with naphthols, brom phenol, iodo phenol, tri bromo phenol, tri chloro phenol, catechol, resorcinol, p xylenol and with phenyl,acetic acid are given by Bennett and Wain, 1936. These authors also give similar results for the cyclic oxides $C_{15}H_{22}O$ and $C_{18}H_{20}O$.

**ε PHENYL CAPROIC ACID** $CH_2(C_6H_5)(CH_2)_4COOH$.

100 gms. $H_2O$ dissolve 0.048 gm. $C_{12}H_{16}O_2$ at 30° and 0.077 gms. at 40°.
(Daniels and Lyons, 1931.)

**ARBUTIN** $C_{12}H_{16}O_7.\frac{1}{2}H_2O$.

100 gms. trichlorethylene dissolve 0.011 gm. arbutin at 15°.
(Wester and Bruins, 1914.)

3.5 Dimethoxy**ACETOPHENETIDE** hydrate $C_{12}H_{17}O_4N.H_2O$.

Solubility in Water. (Bogert and Ehrlich, 1919.)

The freezing-point method was used up to 57° and the sealed tube method above this temperature and for the solubility of the liquid hydrate in water.

| | Results for the solid Hydrate. | | Results for the liquid hydrate. | | |
|---|---|---|---|---|---|
| | Gms. $C_{12}H_{17}O_4N.H_2O$ per 100 gms. | Mol. per cent $C_{12}H_{17}O_4N$. | | Gms. $C_{12}H_{17}O_4N.H_2O$ per 100 gms. | Mol. per cent $C_{12}H_{17}O_4N$. |
| t°. | $H_2O$. | $H_2O$. | t°. | $H_2O$. | $H_2O$. |
| 21.8.. | 0.1444 | 0.010 | 68.5.. | 3.39 | 0.237 |
| 39.9.. | 0.288 | 0.020 | 58.1.. | 3.39 | 0.237 |
| 57.0.. | 0.6492 | 0.046 | 84.3.. | 3.68 | 0.257 |
| 69.5.. | 1.087 | 0.076 | 45.6.. | 3.68 | 0.257 |
| 72.8 .. | 1.297 | 0.091 | 99.8.. | 4.33 | 0.303 |
| 77.1.. | 1.716 | 0.120 | 35.6.. | 4.30 | 0.301 |
| 80.2.. | 2.152 | 0.151 | 111.1.. | 5.15 | 0.361 |
| 82.6.. | 2.582 | 0.180 | 118.4.. | 5.80 | 0.407 |
| 84.2.. | 2.897 | 0.203 | 129.2.. | 7.12 | 0.499 |
| 86.9.. | 3.685 | 0.257 | 173.6.. | 29.01 | 2.041 |

**DIACETYL DIETHYL d TARTRATE** $(CHOCOCH_3CO_2C_2H_5)_2$.

Freezing-point data are given for mixtures of diacetyl diethyl tartrate and:

Diacetyl diethyl r tartrate(2)
Ethylene bromide(1)(4)
Naphthalene(3)(4)
Nitro benzene(4)
" toluene(4)
Phenol(4)
p Xylene(1)

(1) Bruni and Finzi, 1905; (2) Findlay and Campbell, 1928; (3) Palazzo and Batelli, 1883; (4) Scheuer, 1910.

**DIPROPIONYL DIMETHYL d TARTRATE** $(CHOCOC_2H_5CO_2CH_3)_2$.

Freezing-point data for mixtures of the dipropionyl dimethyl d and r tartrates are given by Findlay and Campbell, 1928.

**DEXTRIN** $C_{12}H_{20}O_{10}$.

Solubility in Water. (Lewis, 1914.)

"In the case of dextrin, however, no matter how small an amount of water be employed, under no condition does the concentration of the solution remain constant, while on the other hand the addition of further solvent, never fails to dissolve additional dextrin, although the use of no amount of water, however large, will dissolve the whole of the sample."

100 gms. pyridine dissolve 65.44 gms. dextrin at 20–25°.
100 gms. aq. 50% pyridine dissolve 102 gms. dextrin at 20–25°. (Dehn, 1917. "

**ETHYL SUBERATE** $(CH_2)_6(COOC_2H_5)_2$.

100 cc $H_2O$ dissolve 0.068 gm. $(CH_2)_6(COOC_2H_5)_2$ at 20°. (Sobotka and Kahn, 1931.)

n **DECYL MALONIC ACID** $CH(C_9H_{19})(COOH)_2$.

100 gms. $H_2O$ dissolve 0.0025 gm. $CH(C_9H_{19})(COOH)_2$ at 25°.
" " $C_6H_6$ " 0.0066 " " " " "
(Verkade and Coops, Jr., 1930a.)

Iso **BUTYL TARTRATES** d, l and r $[CHOH.CO_2C_4H_9]_2$

SOLUBILITY OF d AND OF r ISO BUTYL TARTRATES AND OF THEIR MIXTURES IN ETHYL ALCOHOL.
(Campbell, 1929.)

| t° | Gms. per 100 gms. $C_2H_5OH$ | | |
|---|---|---|---|
| | d Tartrate | r Tartrate | d + r Tartrates |
| 0 | 35.0 | 34.9(1) | 33.75 d + 18.35 l |
| 18 | 50.7 | 56.9(1) | 101.85 d + 51.15 l |
| 25 | 58.4 | 71.5(1) | 117.75 d + 58.25 l |

(1) Total d + l.

These results show that "the total solubility is always increased by additions of the active form to the inactive, i.e. the liquid phase becomes active. At all the above temperatures, therefore, the solid inactive form is a solid racemate."

The author also gives results for the freezing-points of mixtures of iso butyl d and l tartrates.

**SUGAR** (Sucrose) $C_{12}H_{22}O_{11}$ (Cane Sugar).

FREEZING-POINTS OF AQUEOUS SOLUTIONS OF CANE SUGAR.
(Kremann and Eitel, 1923.)

| t° of f. pt. | Gms. $C_{12}H_{22}O_{11}$ per 100 gms. sat. sol. | t° of f. pt. | Gms. $C_{12}H_{22}O_{11}$ per 100 gms. sat. sol. | t° of f. pt. | Gms. $C_{12}H_{22}O_{11}$ per 100 gms. sat. sol. |
|---|---|---|---|---|---|
| -0.58,-0.61 | 9.234 | - 5.70,- 5.75 | 43.77 | (-10.42, | 56.52) |
| - 1.51,-1.57 | 19.472 | - 6.03,- 6.64 | 44.73 | -11.95,-12.21 | 58.37 |
| -2.31,-2.35 | 25.98 | - 7.39,- 7.46 | 48.52 | (-12.46 | 60.00) |
| -3.03,-3.15 | 31.75 | - 7.78,- 7.84 | 50.00 | (-13.68 | 62.12 |
| (-4.03, | 37.51) | - 8.34,- 8.58 | 51.48 | -14.43,-14.51 | 62.58 |
| -4.25, | 37.75 | 10.27,-10.34 | 54.88 | (-13.9 Eutec. | 62.40) |
| | | | | (-17.0 | 66.67) |

The results in parentheses are by Mondain-Monval, 1925.
The eutectic as given by Kremann and Eitel is at — 14°.5 and 62.5 % $C_{12}H_{22}O_{11}$.

## Solubility of Cane Sugar in Water.

(Herzfeld, 1892; see also Courtonne, 1877.)

| t°. | Gms. $C_{12}H_{22}O_{11}$ per 100 Gms. | | t°. | Gms. $C_{12}H_{22}O_{11}$ per 100 Gms. | |
|---|---|---|---|---|---|
| | Solution. | Water. | | Solution. | Water. |
| 0 | 64.18 | 179.2 | 40 | 70.42 | 238.1 |
| 5 | 64.87 | 184.7 | 45 | 71.32 | 248.7 |
| 10 | 65.58 | 190.5 | 50 | 72.25 | 260.4 |
| 15 | 66.33 | 197 | 60 | 74.18 | 287.3 |
| 20 | 67.09 | 203.9 | 70 | 76.22 | 320.4 |
| 25 | 67.89 | 211.4 | 80 | 78.36 | 362.1 |
| 30 | 68.70 | 219.5 | 90 | 80.61 | 415.7 |
| 35 | 69.55 | 228.4 | 100 | 82.97 | 487.2 |

Sp. Gr. of sat. solution at 15° = 1.329; at 25° = 1.340.

100 gms. $H_2O$ dissolve 212 gms. cane sugar at 25°, determined by means of Pulfrich's refractometer. (Osaka, 1903–08.)

## Solubility of Cane Sugar in Water.

(Grute and Nussbaum, 1928; Reinders and Klinkenberg, 1929.)

| t° | Gms. $C_{12}H_{22}O_{11}$ per 100 gms. sat. sol. | | t° | Gms. $C_{12}H_{22}O_{11}$ per 100 gms. sat. sol. | |
|---|---|---|---|---|---|
| | G and N | R and K | | G and N | R and K |
| 0 | 64.22 | — | 75 | 77.23 | 78.58(1) |
| 25 | 67.97 | 67.89 | 90 | 80.60 | — |
| 35 | 69.50 | 69.55 | 95 | 81.75 | — |
| 45 | — | 71.3 | 100 | 82.96 | — |
| 50 | 72.24 | — | | | |

(1) Nishizawa and Hachakama, 1929.

## Solubility of Cane Sugar in Water. (Mondain-Monval, 1925.)

The solutions were saturated by two periods of 24 hours constant rotation in a thermostat. The saturated solutions were analyzed polarimetrically. Equilibrium was reached more quickly from below than from above.

| t | 0.9. | 15.8. | 25.6. | 30.5. |
|---|---|---|---|---|
| Gms. $C_{12}H_{22}O_{11}$ per 100 gms. $H_2O$ .... | 180.5 | 196.0 | 210.5 | 218.0 |

The following determinations of the density of saturated aqueous solutions of cane sugar are given by Horiba, 1917.

| t | $d$ of sat. sol. | Gms. $C_{12}H_{22}O_{11}$ per 100 gms sat. sol. |
|---|---|---|
| 0..... | 1.321 | 64.18 |
| 10..... | 1.325 | 65.58 |
| 20..... | 1.329 | 67.09 |
| 30..... | 1.334 | 68.70 |
| 40..... | 1.339 | 70.42 |
| 50..... | 1.344 | 72.25 |
| 60..... | 1.350 | 74.18 |

## Solubility of Sucrose in Aqueous Solutions of Invert Sugar.

(Van der Linden, 1919.)

Results at 30°.

| Gms. per 100 gms. $H_2O$ | |
|---|---|
| Sucrose. | Invert Sugar |
| 219.0 | 0.0 |
| 214.8 | 5.5 |
| 211.9 | 10.5 |
| 204.4 | 26.2 |
| 200.2 | 56.1 |
| 182.9 | 103.2 |
| 180.7 | 121.8 |
| 169.8 | 156.0 |
| 164.0 | 189.1 |
| 150.3 | 268.6 |
| 136.3 | 309.0 |
| 127.1 | 401.4 |

Results at 50°.

| Gms. per 100 gms. $H_2O$ | |
|---|---|
| Sucrose. | Invert Sugar. |
| 260.4 | 0.0 |
| 253.6 | 55.0 |
| 242.1 | 76.5 |
| 230.1 | 144.5 |
| 228.2 | 199.9 |
| 213.9 | 261.5 |
| 202.5 | 314.8 |
| 200.6 | 316.7 |

## Solubility of Cane Sugar in Pure Hydrogen Peroxide.

(Maass and Hatcher, 1922.)

The temperatures were determined at which the last crystal of solid dissapeared in accurately weighed mixtures of the constituents.

| t°. | Gms. $C_{12}H_{22}O_{11}$ per 100 gms. sat. sol. |
|---|---|
| —1.97..... | 3.88 |
| —2.60..... | 11.64 |
| —3.47..... | 18.66 |
| —4.72..... | 25.16 |
| — 5.70..... | 30.94 |
| — 7.57..... | 36.82 |
| —10.30..... | 42.86 |
| —14.32..... | 50.00 |

Determinations of the solubility of sucrose in various samples of the final mother liquor syrups obtained in beet sugar factories located in the Rocky Mountain region of the U.S. are described by Brown, Sharp and Dalberg, 1928, and Brown and Nees, 1933.

## Solubility of Sugar in Aqueous Salt Solutions at 30°, 50°, and 70°.

Interpolated from original results. (Schukow, 1900.)

| t°. | Gms. Salt per 100 Gms. $H_2O$. | Gms. $C_{12}H_{22}O_{11}$ per 100 grams $H_2O$ in Aq. Solution of: KCl. | KBr. | $KNO_3$. | NaCl. | $CaCl_2$. |
|---|---|---|---|---|---|---|
| 30 | 0 | 219.5 | 219.5 | 219.5 | 219.5 | 219.5 |
| " | 10 | 216 | 218 | 217 | 210 | 197 |
| " | 20 | 221 | 220 | 216 | 211 | 189 |
| " | 30 | 228 | 224 | 216 | 219 | 192 |
| " | 40 | 237 | 228 | 217 | 233 | 200 |
| " | 50 | ... | ... | 218 | 250 | 218 |
| " | 60 | ... | ... | ... | 269 | 243 |
| 50 | 0 | 260.4 | 260.4 | 260.4 | 260.4 | 260.4 |
| " | 10 | 261 | 262 | 260 | 255 | 239 |
| " | 20 | 266 | 266 | 261 | 260 | 228 |
| " | 30 | 274 | 272 | 262 | 269 | 228 |
| " | 40 | 284 | 276 | 262 | 284 | 236 |
| " | 50 | 296 | 280 | 263 | 302 | 253 |
| " | 60 | ... | ... | ... | ... | 276 |
| 70 | 0 | 320.5 | 320.5 | 320.5 | 320.5 | 320.5 |
| " | 10 | 326 | 324 | 321 | 323 | 295 |
| " | 20 | 334 | 328 | 324 | 330 | 286 |
| " | 30 | 345 | 334 | 327 | 344 | 286 |
| " | 40 | 357 | 341 | 331 | 361 | 295 |
| " | 50 | 370 | 349 | 334 | 384 | 308 |
| " | 60 | 384 | 357 | 337 | 406 | 327 |

## Solubility of Cane Sugar in Saturated Aqueous Salt Solutions at 31.25°. (Köhler, 1897.)

| Salt. | Gms. Sugar per 100 Gms. Solution. | Gms. Sugar per 100 Gms. Water. | Salt. | Gms. Sugar per 100 Gms. Solution. | Gms. Sugar per 100 Gms. Water. |
|---|---|---|---|---|---|
| $CH_3COOK$ | ... | 324.8 | $Na_2CO_3$ | 64.73 | 229.2 |
| $C_3H_7COOK$ | 49.19 | 306.1 | $KNO_3$ | 61.36 | 224.7 |
| $C_3H_4.OH.(COOK)_3$ | 50.30 | 303.9 | $K_2SO_4$ | 66.74 | 219.0 |
| $K_2CO_3$ | 56.0 | 265.4 | $CH_3COOCa$ | 60.12 | 190.0 |
| KCl | 62.28 | 246.5 | $Na_2SO_4$ | 52.20 | 183.7 |
| $CH_3COONa$ | 59.93 | 237.6 | $CaCl_2$ | 42.84 | 135.1 |
| NaCl | 62.17 | 236.3 | $MgSO_4$ | 46.52 | 119.6 |

## Solubility of Cane Sugar in Aqueous Alcohol Solutions at 14°.

(Schrefeld, 1894.)

| Wt. per cent Alcohol. | Wt. per cent Sugar. | Gms. Sugar per 100 cc. Alcohol-$H_2O$ Mixture. | Wt. per cent Alcohol. | Wt. per cent Sugar. | Gms. Sugar per 100 cc. Alcohol-$H_2O$ Mixture. |
|---|---|---|---|---|---|
| 0 | 66.2 | 195.8 | 50 | 38.55 | 62.7 |
| 5 | 64.25 | 179.7 | 60 | 26.70 | 36.4 |
| 10 | 62.20 | 164.5 | 70 | 12.25 | 13.9 |
| 20 | 58.55 | 141.2 | 80 | 4.05 | 4.2 |
| 30 | 54.05 | 117.8 | 90 | 0.95 | 0.9 |
| 40 | 47.75 | 91. | 100 | 0.00 | 0.0 |

## Solubility of Cane Sugar in Aqueous Alcohol Solutions.

(Scheibler, 1872; correction, 1891.)

| Per cent Alcohol by Vol. | Results at 0°. Sp. Gr. of Solution at 17.5°. | Results at 0°. Gms. Sugar per 100 cc. Solution. | Results at 14°. Sp. Gr. of Solution at 17.5°. | Results at 14°. Gms. per 100 cc. Solution. Sugar. | $C_2H_5OH$. | $H_2O$. | Results at 40°. Gms. Sugar per 100 cc. Solution. |
|---|---|---|---|---|---|---|---|
| 0 | 1.325 | 85.8 | 1.326 | 87.5 | 0 | 45.10 | ... |
| 10 | 1.299 | 80.7 | 1.300 | 81.5 | 3.91 | 44.82 | 95.4 |
| 20 | 1.236 | 74.2 | 1.266 | 74.5 | 8.52 | 43.83 | 90 |
| 30 | 1.229 | 65.5 | 1.233 | 67.9 | 13.74 | 41.87 | 82.2 |
| 40 | 1.182 | 56.7 | 1.185 | 58 | 20.24 | 40.38 | 74.9 |
| 50 | 1.129 | 45.9 | 1.131 | 47.1 | 28.13 | 38.02 | 63.4 |
| 60 | 1.050 | 32.9 | 1.058 | 33.9 | 37.64 | 34.47 | 49.9 |
| 70 | 0.972 | 18.2 | 0.975 | 18.8 | 49.28 | 29.42 | 31.4 |
| 80 | 0.893 | 6.4 | 0.895 | 6.6 | 61.15 | 21.95 | 13.3 |
| 90 | 0.837 | 0.7 | 0.838 | 0.9 | 71.18 | 12.83 | 2.3 |
| 97.4 | 0.806 | 0.08 | 0.808 | 0.36 | 77.39 | 3.28 | 0.5 |

100 gms. absolute methyl alcohol dissolve 1.18 gms. cane sugar at 19°. (de Bruyn, 1892.)

100 gms. aq. 50 per cent pyridine dissolve the following gms. of sugars at 20°–25°; sucrose, 38.5; maltose, 43.07; mannose, 78.70; lactose, 1.98; fructose, 85.42; galactose, 68.3; glucose, 49.17; raffinose, 8.76. (Dehn, 1917.)

100 gms. trichlorethylene dissolve 0.004 gm. cane sugar at 15°. (Wester & Bruins, 1914.)

For additional data on **Galactose**, see p. 448 and on **Glucose**, see p. 445

### Solubility of Cane Sugar in Aqueous Acetone at 25°.

(Herz and Knoch, 1904.)

| Sp. Gr. of Solutions. | cc. Acetone per 100 cc. Solvent. | Gms. Sugar per 100 cc. Solution. | Gms. per 100 cc. Solution. | | |
|---|---|---|---|---|---|
| | | | $H_2O$. | $(CH_3)_2CO$. | $C_{12}H_{22}O_{11}$. |
| 1.3306 | 0 | 89.8 | 43.3 | 0 | 89.8 |
| 1.2796 | 20 | 76.7 | 42.9 | 8.4 | 76.7 |
| 1.2491 | 30 | 72.1 | 39.5 | 13.4 | 72.1 |
| 1.2002 | 40 | 59.3 | 39.8 | 20.9 | 59.3 |
| 1.1613 | 45 | 52.5 | 39 | 24.6 | 52.5 |

Above 45 cc. acetone per 100 cc. solvent the solution begins to separate into two layers. The lower of these contains 51 gms. sugar per 100 cc. and has Sp. Gr. 1.1522. The upper layer contains so little sugar that the amount could not be determined by the method employed. 100 cc. evaporated in a vacuum desiccator left a residue of 3.68 gms. Above the concentration of 80 cc. acetone per 100 cc. solvent the two layers unite. In pure acetone 100 cc. solution gave a residue of 0.18 gm. sugar.

### Solubility of Sucrose in Aqueous Solutions of Lactose and of Lactose in Aqueous Solutions of Sucrose.

(Peter, 1928.)

Results at -3°

| Gms. per 100 gms. sat. solution | | Solid Phase |
|---|---|---|
| Lactose | Sucrose | |
| 0.0 | 64.2 | Sucrose |
| 0.85 | 63.2 | " |
| 1.50 | 62.7 | " |
| 2.18 | 62.1 | " |
| 2.89 | 61.9 | " |
| 2.14 | 58.9 | Lactose |
| 2.70 | 53.63 | " |
| 3.98 | 43.4 | " |
| 5.97 | 28.37 | " |
| 9.85 | 0.0 | " |

Results at 0°

| Gms. per 100 gms. sat. solution | | Solid Phase |
|---|---|---|
| Lactose | Sucrose | |
| 0.0 | 64.5 | Sucrose |
| 0.85 | 63.8 | " |
| 1.72 | 63.0 | " |
| 2.57 | 62.4 | " |
| 3.29 | 61.9 | " |
| 3.76 | 61.45 | " |
| 2.17 | 61.80 | Lactose |
| 4.42 | 43.24 | " |
| 6.48 | 28.54 | " |
| 8.41 | 14.15 | " |
| 10.68 | 0.0 | " |

### Solubility of Several Sugars in Pyridine at 26°.

(Holty, 1905.)

| Sugar. | Formula. | $d_{26}$ of Sat. Sol. | Gms. Sugar per 100 Gms. Sat. Sol. | |
|---|---|---|---|---|
| Cane Sugar (Sucrose) | $C_{12}H_{22}O_{11}$ | ... | 6.45 | |
| Milk Sugar (Lactose) | $C_{12}H_{22}O_{11}.H_2O$ | 0.981 | 2.18 | |
| Grape Sugar (Glucose) | *d* $C_6H_{12}O_6.H_2O$ | 1.005 | 7.62 | |
| Fruit Sugar (Fructose) | *l* $C_6H_{12}O_6$ | 1.052 | 18.49+ | |
| Galactose | $C_6H_{12}O_6$ | 1.0065 | 5.45(?) | |
| Maltose | $C_{12}H_{22}O_{11}$ | ... | 98.10* | (Dehn, 1917.) |
| Mannose | $C_6H_{12}O_6$ | ... | 29.0* | " |
| Raffinose | $C_{18}H_{32}O_{16}.5H_2O$ | ... | 75* | " |

* It is uncertain whether these figures refer to gms. per 100 gms. sat. solution or gms. per 100 gms. pyridine at 20°–25°.

## Solubility of Milk Sugar (Lactose) Hydrate and β Anhydride in Water.

(Hudson, 1904, 1908.)

It was found that the saturation point was reached very slowly with this compound. From the results, it was concluded that "aqueous solutions of milk-sugar contain two substances in equilibrium and that the mutarotation of milk-sugar results from the slow establishment, in cold solutions, of the equilibrium of the balanced reaction, $C_{12}H_{24}O_{12}$ (Hydrate) $\rightleftarrows H_2O + C_{12}H_{22}O_{11}$ (β-anhydride).

The final solubility of hydrated milk sugar was determined by approaching saturation from below and from above with mixtures of water and excess of once recrystallized hydrated milk sugar. These were constantly rotated until equilibrium was reached (one week was allowed in all cases). The filtered saturated solutions were evaporated to dryness and the crystalline residues, consisting of the α and β anhydrides, weighed.

| t°. | Gms. $C_{12}H_{22}O_{11}$ per 100 Gms. Sat. Sol. | t°. | Gms. $C_{12}H_{22}O_{11}$ per 100 Gms. Sat. Sol. |
|---|---|---|---|
| 0 | 10.6 | 49 | 29.8 |
| 15 | 14.5 | 64 | 39.7 |
| 25 | 17.8 | 74 | 46.3 |
| 39 | 24 | 89 | 58.2 |

The initial solubility, obtained by agitating an excess of milk sugar hydrate with water for a few minutes, was somewhat less than one-half the above figures, at temperatures up to 25°.

The final solubility of β anhydrous milk sugar was difficult of determination on account of the high concentration and instability of the saturated solution below 92°. At 0° the final saturation was hastened by addition of 0.1 *n* $NH_4OH$ solution. At 0°, 42.9 gms. $C_{12}H_{22}O_{11}$ per 100 gms. sat. solution were found and at 100°, 61.2 gms.

## Solubility of α and β Lactose (Milk Sugar) in Water. (Gillis, 1920.)

The determinations were made to supplement those of Hudson, 1908. Accurately weighed amounts of the sugar and water were sealed in tubes, and, while being slowly agitated, the temperature was determined at which the last crystal just dissapeared.

The column headings for mol. % and wt. % as given in the original table for α lactose are the reverse of those here shown.

The author gives an exhaustive treatment of the equilibria between the two anhydrous modifications of lactose and considers the system water-milk sugar to be a pseudo ternary system with a transi-dehydration temperature of 93.5°.

Results Obtained with α Lactose.

| t°. | Mol. % $C_{12}H_{22}O_{11}$ In sat. sol. | Gms. $C_{12}H_{22}O_{11}$ per 100 gms. sat. sol. |
|---|---|---|
| 128.4.... | 11.77 | 71.8 |
| 128.0.... | 12.06 | 72.3 |
| 134.0.... | 13.00 | 74.0 |
| 146.2.... | 16.14 | 78.3 |
| 158.1.... | 19.08 | 81.7 |
| 164.1.... | 21.46 | 83.8 |

Results Obtained with β Latose.

| t°. | Mol. % $C_{12}H_{22}O_{11}$ In sat. sol. | Gms. $C_{12}H_{22}O_{11}$ per 100 gms. sat. sol. |
|---|---|---|
| 88.6.... | 6.34 | 58.25 |
| 107.0.... | 8.54 | 63.94 |
| 121.5.... | 10.67 | 69.41 |
| 133.6.... | 12.58 | 73.22 |
| 138.8.... | 13.76 | 75.20 |
| 158.8.... | 18.50 | 81.13 |
| 178.8.... | 25.58 | 86.72 |
| 200.0.... | 39.41 | 92.51 |

### Solubility of Hydrated Lactose in Water. (Saillard, 1919.)

The hydrated lactose which was used contained a trace of mineral matter and less than 0.10 % hygroscopic $H_2O$ as determined by drying at 105°. Constant agitation was employed for obtaining saturation and equilibrium was approached from below and from above. In the latter case the mixture was previously heated to 75°-80°. A trace of formol was added in both cases, before the period of agitation.

| t..... | 21.5 | 28.0 | 38.0 | 48.0 | 57.0 | 65.0 |
|---|---|---|---|---|---|---|
| Gms. $C_{12}H_{22}O_{11}$ per 100 gms. $H_2O$ .. | 20.0 | 24.0 | 30.7 | 42.1 | 56.0 | 77.0 |

Note. — It is pointed out by Gillis, 1920, that the above determinations at 48°, 57° and 65°, and the result of Hudson at 89°, are undoubtedly incorrect. Very carefully made new determinations between 50° and 100°, have confirmed the transi-dehydration temperature of 93°.5 for α and β lactose.

### Solubility of Lactose in Mixtures of Water and Pyridine.
(Pucher and Dehn, 1921.)

| Per cent $C_5H_5N$ in solvent. | Gms. Lactose per 100 gms. solvent at 1° | at 25° | Per cent $C_5H_5N$ in solvent. | Gms Lactose per 100 gms. solvent at 1°. | at 25°. |
|---|---|---|---|---|---|
| 0.0 | 19.18 | 23.04 | 70.0 | 2.85 | 3.22 |
| 10.0 | 17.84 | 22.35 | 80.0 | 1.62 | 2.62 |
| 20.0 | 15.29 | 19.24 | 81.4 | 2.22 | 2.50 |
| 30.0 | 12.93 | 15.48 | 90.0 | 1.75 | 1.77 |
| 40.0 | 9.48 | 10.56 | 91.0 | 1.83 | 1.82 |
| 50.0 | 6.87 | 7.75 | 100.0 | 1.61 | 2.22 |
| 60.0 | 4.61 | 5.62 | | | |

100 gms. Abs. Alcohol dissolve 0.09 gm. Lactose at 20-25°. (Pucher and Dehn, 1921.)
» Quinoline » 1.96 » » »
» Equi. mol. mixture of alcohol and quinoline dissolve 1.32 gm. Lactose at 20-25°.

## MALTOSE $C_{12}H_{22}O_{11} + H_2O$

### Solubility of Maltose in Water.
(Gillis, 1924.)

| t°. | Gms. $C_{12}H_{22}O_{11}$ per 100 gms. Water. | Sat. sol. | Solid Phase. | t°. | Gms. $C_{12}H_{22}O_{11}$ per 100 gms. Water. | Sat. sol. | Solid Phase. |
|---|---|---|---|---|---|---|---|
| — 0.79... | – | 12.23 | Ice | 43.5..... | 123.9 | 55.3 | $C_{12}H_{22}O_{11}.H_2O$ |
| — 1.16... | – | 16.67 | » | 49.4..... | 137.0 | 57.8 | » |
| — 1.87... | – | 23.97 | » | 49.4..... | 142.7 | 58.8 | » |
| + 0.6.... | 55.7 | 35.8 | $C_{12}H_{22}O_{11}.H_2O$ | 54.2..... | 151.4 | 60.2 | » |
| + 0.6.... | 57.3 | 36.4 | » | 59.8..... | 175.2 | 63.7 | » |
| 21.0.... | 78.6 | 44.0 | » | 66.3..... | 200.0 | 66.7 | » |
| 21.0.... | 79.2 | 44.2 | » | 74.2..... | 261.5 | 72.3 | » |
| 29.6.... | 93.2 | 48.0 | » | 87.0..... | 383.8 | 79.3 | » |
| 34.4.... | 98.4 | 49.6 | » | 96.5..... | 569.3 | 85.1 | » |

The determinations above 50° were made by the synthetic method. The temperature of disappearance of the last crystal was determined.

Several determinations of the freezing-point of solutions of maltose in 0.1 *n* ammonia gave the following results.

| t°..... | −1.17. | −1.25. | −1.98. | −2.44. |
|---|---|---|---|---|
| Gms. $C_{12}H_{22}O_{11}$ per 100 gms. sat. sol. | 16.9 | 18.3 | 25.05 | 28.87 |

## LAURIC ACID $C_{11}H_{23}COOH$.

### Solubility in Alcohols.
(Timofeiew, 1894.)

| Alcohol. | t°. | Gms. $C_{11}H_{23}COOH$ per 100 Gms. Sat. Sol. | Alcohol. | t°. | Gms. $C_{11}H_{23}COOH$ per 100 Gms. Sat. Sol. |
|---|---|---|---|---|---|
| Methyl Alcohol | 0 | 14.8 | Propyl Alcohol | 0 | 21.5 |
| " | 21 | 58.6 | " | 21 | 52.6 |
| Ethyl Alcohol | 0 | 20.5 | Isobutyl Alcohol | 0 | 18.4 |
| " | 21 | 57.3 | " | 21 | 49.7 |

### Solubility of Lauric Acid in Aqueous Ethyl Alcohol.

(Ekwall and Mylius, 1932.)

Solubility in aqueous:

| 80 Vol. % $C_2H_5OH$ | | 96 Vol. % $C_2H_5OH$ | | 99.9 Vol. % $C_2H_5OH$ | |
|---|---|---|---|---|---|
| t° | Gms. $CH_3(CH_2)_{10}COOH$ per 100cc solvent | t° | Gms. $CH_3(CH_2)_{10}COOH$ per 100cc solvent | t° | Gms. $CH_3(CH_2)_{10}COOH$ per 100cc solvent |
| 0 | 5.26 | -1 | 14.17 | 0 | 20.84 |
| 6 | 9.15 | +8 | 28.48 | 8 | 36.00 |
| 14 | 22.50 | 12 | 38.65 | 12 | 48.36 |
| 21 | 48.30 | 16.5 | 56.32 | 16.5 | 72.81 |

100 gms. $H_2O$ dissolve 0.00017 gm. undissociated lauric acid at 25°, as determined by conductivity measurements.

100 gms. $C_6H_6$ dissolve 186 gm. lauric acid at 25°; at 40° there is miscibility in all proportions. (McBain and Eaton, 1928.)

The authors also give experiments upon the extraction of lauric acid from aqueous potassium laurate solutions by benzene.

## LAURIC ACID $CH_3(CH_2)_{10}COOH$.

### Freezing-Points of Mixtures of Lauric Acid and Palmitic Acid $[CH_3(CH_2)_{14}CO\,OH]$. (Waentig and Pescheck, 1919.)

The reading for the melting point was taken when a slight rise and holding constant of the thermometer occurred during the gradual cooling of the well stirred mixture of the two fatty acids.

| | Palmitic Acid in mixture | | | Palmitic Acid in mixture | | | Palmitic Acid in mixture | |
|---|---|---|---|---|---|---|---|---|
| t°. | Wt. %. | Mol. %. | t°. | Wt. %. | Mol. %. | t°. | Wt. %. | Mol. %. |
| 60.95... | 100.0 | 100.0 | 48.70... | 61.41 | 55.42 | 39.15... | 42.02 | 36.15 |
| 59.48... | 94.0 | 92.4 | 48.05... | 59.96 | 53.92 | 38.03... | 37.65 | 32.06 |
| 58.40... | 89.87 | 87.39 | 47.28... | 58.06 | 51.96 | 37.60... | 34.97 | 29.58 |
| 57.16... | 85.59 | 82.27 | 46.45... | 56.31 | 50.17 | 37.12... | 31.95 | 26.84 |
| 56.16... | 82.04 | 78.11 | 45.57... | 54.72 | 48.56 | 36.34... | 28.39 | 23.65 |
| 55.22... | 78.83 | 74.42 | 44.08... | 52.16 | 46.00 | 35.50... | 24.64 | 20.35 |
| 54.15... | 75.66 | 70.83 | 43.53... | 51.92 | 45.76 | 36.33... | 20.32 | 16.61 |
| 53.12... | 72.62 | 67.45 | 43.00... | 51.45 | 45.29 | 36.90... | 16.17 | 13.16 |
| 52.10... | 69.91 | 64.48 | 42.78... | 49.09 | 42.97 | 38.26... | 10.87 | 8.70 |
| 51.26... | 67.60 | 61.98 | 42.63... | 47.83 | 41.72 | 40.55... | 5.32 | 4.21 |
| 50.45... | 65.40 | 59.63 | 41.70... | 46.22 | 40.17 | 43.35... | 0.00 | 0.00 |
| 49.45... | 63.24 | 57.34 | 40.55... | 44.32 | 38.34 | | | |

Results for the freezing-points of mixtures of Lauric and Undecylic acids and for mixtures of Lauric and Capric acids are given by Kulka and Sandin, 1937.)

## Tri LAURIN $C_3H_5(O.C_{12}H_{23}O)_3$.

100 gms. abs. alcohol dissolve 6.66 gms. Trilaurin at 20-25° } (Pucher and Dehn, 1921.)
» Quinoline » 18.22 » » }
» equi mol. mixture of alcohol and Quinoline dissolve 16.57 gms. Trilaurin at 20-25°.

### Solubility of Trilaurin in Several Solvents.
(Loskit, 1928.)

The determinations were made by the thermic, the sealed tube and the analytical method. The author's results were plotted and the following table constructed from the curves.

| t° | Gms. $C_3H_5[CH_3(CH_2)_{10}COO]_3$ per 100 gms. sat. solution in: | | | |
|---|---|---|---|---|
| | $C_6H_6$ | $(C_2H_5)_2O$ | $CHCl_3$ | $CS_2$ |
| -10.0 | — | — | 15 | 0.5 |
| - 5.0 | — | 1.0 | 20 | 1.5 |
| 0.0 | — | 2.0 | 25 | 4.2 |
| 2.0 | (23.5*) | 2.7 | — | 6.0 |
| 3.0 | (20.0*) | 3.3 | 28.5 | 7.5 |
| 4.0 | 14.0(14.0) | 3.7 | — | 9.0 |
| 5.0 | 15.0( 3.0) | 4.3 | 30.7 | 10.5 |
| 10 | 27.5 | 10.2 | 36.7 | 21.0 |
| 15 | 40.0 | 21.5 | 43.5 | 35.0 |
| 20 | 51.5 | 36 | 50.5 | 47.5 |
| 25 | 61.5 | 52.2 | 59.0 | 60.0 |
| 30 | 71.0 | 66.5 | 67.0 | 71.0 |
| 35 | 81.0 | 78.0 | 76.5 | 81.0 |
| 40 | 91.0 | 88.0 | 88.0 | 91.0 |

The results in parentheses are for solutions in contact with benzene as solid phase. * = unstable.

**PHENACYL LAURATE** $CH_3(CH_2)_{10}COO.CH_2COC_6H_5$ etc.

### Solubility of Phenacyl, Bromophenacyl and Chlorophenacyl Laurates in 95 % Ethyl Alcohol.
(Hann, Reid and Jameson, 1930.)

| Compound | Formula | Gms. laurate per 100cc 95% alcohol at: 20° | 25° |
|---|---|---|---|
| Phenacyl laurate | $CH_3(CH_2)_{10}COO.CH_2COC_6H_5$ | 2.915 | 5.3800 |
| p Bromo " " | $CH_3(CH_2)_{10}COOCH_2COC_6H_4Br$ | 0.3832 | 0.4288 |
| p Chloro " " | $CH_3(CH_2)_{10}COOCH_2COC_6H_4Cl$ | 0.6060 | 0.7856 |

**ETHYL CAPROATE** $CH_3(CH_2)_8COOC_2H_5$.

100cc $H_2O$ dissolve 0.0015 gm. $CH_3(CH_2)_8COOC_2H_5$ at 20°. (Sobotka and Kahn, 1931.)

**DODECANE** $CH_3(CH_2)_{10}CH_3$.

The critical solution temperature of mixtures of dodecane and liquid sulfur dioxide is 47° and there is 95 Mol. % $SO_2$ in the mixture at this temperature. (Leslie, 1934.)

Freezing-point data for mixtures of dodecane and dotriacontane (Dicetyl) are given by Seyer, 1938.

**2-BROMO NITRO FLUORENONE** $C_{13}H_6OBrNO_2$ (m.pt. 230°).

100 gms. $C_2H_5OH$ dissolve less than 0.25 gm. $C_{13}H_6OBrNO_2$ at 18°.
" " $C_6H_6$ " 0.2 gm. $C_{13}H_6OBrNO_2$ at 18°.
" " $CHCl_3$ " 0.435" " " " (Courtot, 1930.)

**2-CHLORO NITRO FLUORENONE** $C_{13}H_6OClNO_2$ (m.pt. 230°).

100 gms. $C_2H_5OH$ dissolve less than 0.4 gm. $C_{13}H_6OClNO_2$ at 18°.
" " $C_6H_6$ " " " 0.25 " " " " "
" " $CHCl_3$ " " " 0.26 " " " " " (Courtot, 1930.)

**FLUORENONE** $C_6H_4COC_6H_4$.

Freezing-point data are given for mixtures of fluorenone and:

Acenaphthene (Pfeiffer, 1924; Pfeiffer, Goebel and Angern, 1925.)
Naphthylamine (Pfeiffer, Goebel and Angern, 1925.)
s Tri nitro benzene (Sudborough and Beard, 1911.)

**2- BROMO NITRO FLUORENONE OXIME** $C_{13}H_8OBr$ (m.pt. 233°-4).

100 gms. $C_2H_5OH$ dissolve less than 0.25 gm. $C_{13}H_8OBr$ at 18°.
" " $C_6H_6$ " 0.28 " " " " "
" " $CHCl_3$ " 0.2 " " " " " (Courtot, 1930.)

**XANTHONE** (9-Xanthenone) $C_{13}H_8O_2$
100 gms. Carbon Tetrachloride dissolve 0.96 gm. Xanthone at 20° } (Pawlewski, 1914, 1926.)
» » Chloroform » 11.24 » » » » » }

Freezing-point data for mixtures of xanthone and s tri nitro benzene are given by Sudborough and Beard, 1911.

**2-BROMO NITRO FLUORENE** $C_{13}H_8BrNO_2$ (m.pt. 236°).

100 gms. $C_2H_5OH$ dissolve less than 0.25 gm. $C_{13}H_8BrNO_2$ at 18°.
" " $C_6H_6$ " 0.31 " " " " "
" " $CHCl_3$ " 0.36 " " " " " (Courtot, 1930.)

**2-CHLORO NITRO FLUORENE** $C_{13}H_8ClNO_2$ (m.pt. 237°)

100 gms. $C_2H_5OH$ dissolve less than 0.25 gm. $C_{13}H_8ClNO_2$ at 18°.
" " $C_6H_6$ " 0.37 " " " " "
" " $CHCl_3$ " 0.43 " " " " " (Courtot, 1930.)

**2-CHLORO AMINO FLUORENONE** $C_{13}H_6OClNH_2$ (m.pt. 203-5°)

100 gms. $C_2H_5OH$ dissolve less than 0.3 gm. $C_{13}H_6OClNH_2$ at 18°.
" " $C_6H_6$ " " " 0.37 " " " " "
" " $CHCl_3$ " " " 0.4 " " " " " (Courtot, 1930.)

## DINITRO PHENYL CARBONATE $(C_6H_4NO_2)_2CO_3$.

Freezing-point data for mixtures of the isomers of dinitro phenyl carbonate are given by Hoeflake, 1921.

## BROM BENZOYL p NITRANILINE $C_{13}H_9O_3N_2Cl$.

Freezing-point data are given by Lettre and Barnbeck, 1938, for binary mixtures of o, m and p brom, chlor and methyl benzoyl p nitranilines.

## ACRIDINE $C_6H_4\langle CH \rangle C_6H_4$ (N)

Freezing-point lowering data are given for mixtures of Acridine and each of the following compounds :

Anthracene (Pascal, 1921.)
Methyl acridine »
Carbazole »
Nitrosodimethylaniline (Kremann and Wlk, 1919.)
Hydroquinol (Kremann and Slovak, 1920.)
α and β Naphthol (Kremann and Slovak. 1920.)
Phenanthrene (Pascal, 1921.)
Phenol (Kremann and Slovak, 1920.)
Pyrocatechol »
Resorcinol »

Results for mixtures of 5.phenylacridine and picric acid are given by Bassett and Simmons, 1921.

## 3,5-DIBROM-4-AMINO BENZOPHENONE $C_6H_3Br_2COC_6H_4NH_2$.

Freezing-point data for mixtures of 3.5 dibrom -4-amino benzo phenone and 3-Brom, 5 iodo, 4 amino benzo phenone are given by Gibby and Waters, 1931.

## Polymorphic Nitro BENZALDEHYDRAZONES $C_{13}H_9O_2Cl_2N_3$.

### Solubility of the Stable and Labile Forms of Polymorphic Nitrobenzaldehydrazones in Alcohol.

(Chattaway and Walker, 1924.)

Equilibrium attained by constant shaking for 4 to 6 hours in the case of the stable forms and 1 to 2 hours in the case of the labile forms. The solutions were analyzed by evaporating and weighing the residues.

Results for :
*o* Nitrobenzaldehyde-2-chloro-4-bromo-phenyl hydrazone.

| t°. | Gms. cmpd per 100 gms. sat. sol. Stable form. | Labile form. |
|---|---|---|
| 0.05..... | 0.039 | 0.073 |
| 5.25..... | 0.047 | 0.082 |
| 10.5..... | 0.056 | 0.093 |
| 15.0..... | 0.065 | 0.106 |
| 18.0..... | – | 0.118 |
| 20.0..... | 0.079 | – |
| 25.0..... | 0.093 | 0.150 |
| 30.0..... | 0.116 | 0.179 |
| 37.85..... | 0.159 | – |

Results for :
*p* Nitrobenzaldehyde-2:4-dichloro-phenyl hydrazone.

| t°. | Gms. cmpd per 100 gms. sat. sol. Stable form. | Labile form. |
|---|---|---|
| 0.05..... | 0.052 | 0.079 |
| 5.85..... | 0.057 | 0.086 |
| 11.90..... | 0.064 | 0.097 |
| 16.0..... | 0.075 | 0.105 |
| 21.5..... | 0.087 | 0.126 |
| 29.85..... | 0.115 | 0.173 |
| 34.80..... | 0.142 | 0.225 |
| 39.34..... | 0.173 | – |
| 44.15..... | 0.214 | – |

*p* Nitrobenzaldehyde-4-chloro-2-bromo phenyl hydrazone (Stable form).

| t°. | Gms. per 100 gms. sat. sol. | t°. | Gms. per 100 gms. sat. sol. | t°. | Gms. per 100 gms. sat. sol. |
|---|---|---|---|---|---|
| 0.05..... | 0.034 | 20.0..... | 0.066 | 33.5..... | 0.109 |
| 12.5..... | 0.052 | 26.9..... | 0.087 | 40.05..... | 0.141 |

**FLUORENE** (Diphenylene methane) $C_6H_4CH_2C_6H_4$.

SOLUBILITY OF FLUORENE IN SEVERAL SOLVENTS. (Mortimer, 1923.)

| | Mols. $C_6H_4.CH_2.C_6H_4$ per 100 mols. of saturated solution in | | | | | | |
|---|---|---|---|---|---|---|---|
| t°. | Ethylene dichloride. | Chloro benzene. | Nitro benzene | *p* xylene. | Toluene. | Benzene. | Pyridine. |
| 0 ... | 7.1 | 6.6 | 6.3 | 5.5 | 5.4 | 5.4 | 5.1 |
| 20.... | 12.9 | 12.4 | 11.8 | 11.2 | 10.6 | 10.5 | 10.1 |
| 40.... | 22.0 | 21.4 | 20.6 | 19.3 | 19.1 | 19.0 | 18.3 |
| 60.... | 35.6 | 34.9 | 34.1 | 32.7 | 32.4 | 32.4 | 31.4 |
| 80.... | 54.1 | 53.3 | 52.5 | 51.3 | 51.1 | 51.1 | 49.9 |
| 100.... | 78.4 | 78.2 | 77.1 | 76.6 | 76.5 | — | 75.5 |

| | Mols. $C_6H_4.CH_2.C_6H_4$ per 100 mols. of saturated solution in | | | | | |
|---|---|---|---|---|---|---|
| t°. | Carbon tetra chloride | Aniline. | Acetone. | Acetic acid. | Ethyl alcohol | Methyl alcohol. |
| 0..... | 3.7 | 2.4 | 2.0 | — | — | — |
| 20..... | 7.8 | 5.6 | 4.7 | 0.8 | 0.50 | 0.35 |
| 40..... | 15.1 | 11.7 | 10.4 | 1.9 | 0.85 | 0.58 |
| 60..... | 27.5 | 23.2 | 15.0 (50°) | 4.5 | 1.76 | 1.10 |
| 80..... | — | 42.7 | — | 11.3 | 4.60 | — |
| 100..... | — | 71.0 | — | 40.0 | — | — |

100 gms. sat. solution of fluorene in liquid sulfur dioxide contain 24 gms. $C_6H_4CH_2C_6H_4$ at ? t°. (De Carli, 1927.

**FLUORENE**

Freezing-point data are given for mixtures of Fluorenone and:

Dinitro benzenes(4)(8)
" phenol(4)
" toluenes(4)(5)
Naphthylamines(7)
Picramide(1)
Picric acid(4)
Picryl chloride(1)
Quinone(6)
Styphnic acid(1)
Tetra nitro benzene(8)
Tetryl(3)
Trinitro benzene(4)
" cresol(2)
" m xylol(3)
" toluene(4)

(1) Jefremow, 1916; (2) Jefremow and Tichomirowa, 1927; (3) Jefremow and Tichomirowa, 1928; (4) Kremann, 1911; (5) Kremann, Hönigsberg and Mauermann, 1923; (6) Kremann, Sutter, Sitte, Strzelba and Dobotzky, 1922; (7) Pfeiffer, 1924; (8) Shinomiya, 1940.

**2-BROMO AMINO FLUORENE** $C_{13}H_8.Br.NH_2$. (m.pt.146°)

100 gms. $C_2H_5OH$ dissolve 1.0 gm. $C_{13}H_8BrNH_2$ at 18°.
" " $C_6H_6$ " 2.86 " " " " "
" " $CHCl_3$ " 4.00 " " " " " (Courtot, 1930.)

**2-CHLORO AMINO FLUORENE** $C_{13}H_8Cl.NH_2$ (m.pt.133°)

100 gms. $C_2H_5OH$ dissolve 1.66 gm. $C_{13}H_8ClNH_2$ at 18°.
" " $C_6H_6$ " 4.54 " " " " "
" " $CHCl_3$ " 5.00 " " " " " "

## BENZOPHENONE $(C_6H_5)_2CO$.

### Solubility in Aqueous Alcohol and in other Solvents.

(Derrien — Compt. rend. 130, 722, '00; Bell — J. Physic. Chem. 9, 550, '05.)

### In Aqueous Alcohol at 40°.

(Bell.)

| Wt. % Alcohol in Solvent. | Gms. $(C_6H_5)_2CO$ per 100 Gms. Solvent. | Gms. $(C_6H_5)_2CO$ per 100 Gms. Solution. | Wt. % Alcohol in Solvent. | Gms. $(C_6H_5)_2CO$ per 100 Gms. Solvent. | Gms. $(C_6H_5)_2CO$ per 100 Gms. Solution. |
|---|---|---|---|---|---|
| 40 | 2 | 1.9 | 67.5 | 39 | 28.1 |
| 45 | 5 | 4.8 | 70 | 56 | 35.9 |
| 50 | 8 | 8.3 | 71 | 67 | 39.2 |
| 55 | 11 | 9.9 | 72 | 90 | 47.4 |
| 60 | 16 | 13.8 | 72.5 | 105 | 51.2 |
| 65 | 28 | 22.6 | 73 | 156 | 61.0 |

### In Aqueous Alcohol and other Solvents.

(Derrien.)

| Solvent. | t°. | Gms. $(C_6H_5)_2CO$ per 100 cc. Solvent. | Solvent. | t°. | Gms. $(C_6H_5)_2CO$ per 100 cc Solvent. |
|---|---|---|---|---|---|
| 97% Ethyl Alcohol | 17 | 13.5 | Ethyl Ether (rectified) | 12.7 | 17.5 |
| 85 cc. 97% Alcohol + 15 cc. $H_2O$ | 17 | 3.8 | Benzene | 17 | 76.9 |
| 80 " " + 20 " | 17 | 2.2 | Xylene | 17.6 | 38.4 |
| 75 " " + 26 " | 17 | 1.3 | Nitro Benzene | 15.8 | 58.8 |
| Methyl Alcohol (pure) | 9.8 | 11 | Chloroform (com.) | 16.5 | 55.5 |
| " " " | 15 | 14.3 | Bromoform | 17.3 | 33.3 |
| Acetic Ether (pure) | 9.6 | 19.2 | Toluene | 17.2 | 55.5 |
| Carbon Disulfide | 16.1 | 66.6 | Ligröine | 14.6 | 6.7 |

Determinations made by means of the Pulfrich refractometer (Osaka, 1903-8), gave 39 gms. benzophenone per 100 gms. absolute ethyl alcohol at 20°, and 78.6 gms. benzophenone per 100 gms. benzene at 25°.

### BENZOPHENONE

Freezing-point data are given for mixtures of benzophenone and:

Azobenzene(2)
Azoxyanisole(6)
Benzene(13)
Bibenzyl(14)
Benzohydrol(1)
Dinitro phenol(7)
Diphenyl + diphenyl amine(3)(12)
Diphenylamine(4)
Hydroquinone(9)
Naphthols(9)
Naphthylamines(8)
Nitrophenols(9)
Phenol(9)
Picric acid(7)(18)
Pyrocatechol(5)(9)
Pyrogallol(9)
Resorcinol(5)(9)(15)(16)
Sulfuric acid(10)
Thymol(17)
Toluidine(8)
Trichlor acetic acid(11)
Trinitro phenol(18)

(1) Boeseken, 1921; (2) Erlenmeyer and Leo, 1933; (3) Giua, 1915; (4) Giua and Cherchi, 1919; (5) Freundlich and Posnjak, 1912; (6) de Kock, 1904; (7) Kremann and Marktl, 1920; (8) Kremann and Schadinger, 1918; (9) Kremann and Zechner, 1918; (10) Kendall and Carpenter, 1914; (11) Kendall and Gibbons, 1915; (12) Lee and Warner, 1933; (13) Loskit, 1928; (14) Malataux and Straub, 1937; (15) Pfeiffer, 1924; (16) Pfeiffer, Goebel and Angern, 1925; (17) Pawlewski, 1893; (18) Puschin and Rikovski, 1930.

## 2-BROMO AMINO FLUORENOL $C_{13}H_8OBrNH_2$. (m.pt. 186°-7)

100 gms. $C_2H_5OH$ dissolve 0.41 gm. $C_{13}H_8OBrNH_2$ at 18°.
" " $C_6H_6$ " less than 0.22 gm. $C_{13}H_8OBrNH_2$ at 18°.
" " $CHCl_3$ " " " 0.13 " " " (Courtot, 1930.)

**PHENYL BENZOATE** $C_6H_5COOC_6H_5$.

Freezing-point data are given for mixtures of:

Phenyl benzoate + Naphthalene (Bernoulli and Sarasin, 1930.)
" " + Trichlor acetic acid (Kendall and Booge, 1916.)

**SALOL** (Phenylsalicylate) $C_6H_4.OH.COOC_6H_5$, 1.2.

SOLUBILITY OF SALOL IN AQUEOUS ALCOHOL AT 25°. (Seidell, 1909, 1910.)

| Wt. Per cent $C_2H_5OH$ in Solvent. | $d_{25}$ of Sat. Sol. | Gms. Salol per 100 Gms. Sat. Sol. | Wt. Per cent $C_2H_5OH$ in Solvent. | $d_{25}$ of Sat. Sol. | Gms. Salol per 100 Gms. Sat. Sol. |
|---|---|---|---|---|---|
| 0 | 0.999 | 0.015 | 70 | 0.877 | 4.40 |
| 20 | 0.967 | 0.020 | 80 | 0.863 | 7.70 |
| 40 | 0.934 | 0.22 | 90 | 0.865 | 14 |
| 50 | 0.914 | 0.76 | 92.3 | 0.868 | 17.70 |
| 60 | 0.895 | 2.10 | 100 | 0.898 | 35 |

SOLUBILITY OF SALOL IN SEVERAL SOLVENTS. (Seidell, 1907.)

| Solvent. | t°. | d Sat. Sol. | Gms. Salol per 100 Gms. Sat. Sol. | Solvent. | t°. | d Sat. Sol. | Gms. Salol per 100 Gms. Sat. Sol. |
|---|---|---|---|---|---|---|---|
| Acetone | 30–31 | ... | 90.99 | Amyl Alcohol | 25 | 0.869 | 20.44 |
| Benzene | 30–31 | 1.148 | 88.57 | Acetic Acid (99.5%) | 21.5 | 1.143 | 63.24 |
| Amyl Acetate | 30–31 | 1.136 | 85.29 | Xylene | 32 5 | ... | 87.14+ |
| Aniline | 30–31 | ... | very soluble | Toluene | 25 | 1.128 | 83.62 |

100 gms. pyridine dissolve 381 gms. salol at 20°–25° (Dehn, 1917). The solution in aqueous 50 per cent pyridine separates into two layers.

100 gms. benzene dissolve approximately 229 gms. $C_6H_4OHCOOC_6H_5$ at 25°.
" " $CCl_4$ " " 285 " " " " "
" " Pet. benzine" " 91 " " " " "

(Warren, 1933.)

SOLIDIFICATION TEMPERATURES FOR MIXTURES OF:

Salol and Thymol. (Bellucci, 1912.)

| t° of Solidif. | Gms. Salol per 100 Gms. Mixture. | t° of Solidif. | Gms. Salol per 100 Gms. Mixture. |
|---|---|---|---|
| 42 | 100 | 23 | 50 |
| 34 | 90 | 29 | 40 |
| 26 | 80 | 34.5 | 30 |
| 18 | 70 | 40 | 20 |
| 13 Eutec. | 66 | 46 | 10 |
| 17 5 | 60 | 51 | 0 |

Salol and Urethan. (Bellucci, 1912, 1913.)

| t° of Solidif. | Gms. Salol per 100 Gms. Mixture. | t° of Solidif. | Gms. Salol per 100 Gms. Mixture. |
|---|---|---|---|
| 42 | 100 | 36.5 | 50 |
| 36.5 | 90 | 39 | 40 |
| 29 Eutec. | 86 | 41.5 | 30 |
| 31 | 80 | 44 | 20 |
| 30 | 70 | 47 | 10 |
| 34 | 60 | 48.5 | 0 |

The Eutec. for salol + camphor is at +6° and contains 56% salol.
The Eutec. for salol + monobromcamphor is at 21° and contains 60% salol. (Bellucci, 1912, 13.)
Solidification temperatures for Salol + Sulfonal and for Salol + β Naphthol are given by Bianchini (1914).

## PHENYL SALICYLATE

Freezing-point data are also given for mixtures of Salol and the following compounds:

Acetanilide(10)
Antipyrine(1)(9)(19)
" + Phenacetine(8)
Benzene(16)
Benzo naphthalene(2)
Benzoyl β Naphthol(2)
Bromural(13)(20)
Camphor(7)(15)
Chlor acetic acid(21)
Chloral hydrate(4)
Cineole(5)
Guaiacol(4)
Menthol(1)(4)(9)
Methyl acetanilide(3)
Naphthalene(3)(18)
" + Sulfonal(6)
Naphthol(19)
Phenacetine(1)(9)(19)
" + Antipyrine(8)
Phenylene diamine(17)
Quinine(1)(9)
Resorcinol(11)
Sulfonal(19)
" + Naphthol(6)
Terpine hydrate(3)
Thymol(12)
Tri chlor acetic acid(14)
Urea(1)(9)
Urethan(1)(9)
Veronal(13)

(1) Adamanis, 1933; (2) Angeletti, 1927; (3) Angeletti, 1928; (4) Bellucci, 1912, 1913; (5) Bellucci and Grassi, 1913; (6) Bianchini, 1914; (7) Caille, 1909; (8) Hrynakowski, 1934; (9) Hrynakowski and Adamanis, 1933; (10) Hrynakowski and Adamanis, 1933a; (11) Hrynakowski and Adamanis 1933b; (12) Hrynakowski and Szmyt, 1935; (13) Hrynakowski and Szmyt, 1935d; (14) Kendall and Booge, 1916; (15) LeFevre and Webb, 1931; (16) Loskit, 1928; (17) Puschin and Dezelic, 1938; (18) Puschin and Grebenschtschikow, 1925; (19) Quercigh and Cavagnari, 1912; (20) Sandqvist and Hök, 1927; (21) Mameli and Mannessier, 1913.

## Di PHENYL CARBONATES.

Freezing-point lowering data are given for mixtures of diortho nitro diphenyl carbonate, di para nitro diphenyl carbonate and ortho para nitro diphenyl carbonate by Hœflake, 1921.

## Methylphenyl PICRAMIDES. $(NO_2)_3C\ (CH_3)(C_6H_5)NH_2$.

SOLUBILITY IN ETHYL ALCOHOL AT 18°.
(Hantzsch, 1911.)

100 cc. $C_2H_5OH$ dissolve 0.32 gm. of the isomer melting at 108°.
100 cc. $C_2H_5OH$ dissolve 0.42 gm. of the isomer melting at 128°.

## N-BENZAL ANILINE $C_6H_5CH{:}NC_6H_5$.

100 gms. sat. solution of N-Benzal aniline in liquid sulfur dioxide contain 53 gms. $C_6H_5CH{:}NC_6H_5$ at ? t°. (DeCarli, 1927.)

Freezing-point data are given for mixtures of N-Benzal aniline and:

Anisylidene aniline(1)
Azobenzene(2)
Benzanilide(3)
Benzylaniline(2)
Benzoin(3)
Dibenzyl(2)
Hydrazo benzene(2)
Stilbene(2)
Tolane(2)

(1) Pascal, 1923; (2) Pascal and Normand, 1913; (3) Vanstone, 1913.

**BENZANILIDE** $C_6H_5CONHC_6H_5$.

SOLUBILITY OF BENZANILIDE IN AQUEOUS SOLUTIONS OF ACETIC ACID.
(Bradfield and Williams, 1929.)

The determinations were made by the synthetic method and the eight or nine determinations over the range 15-40° were plotted and the values for regular intervals of temperature read from the curves.

| Gms. $CH_3COOH$ per 100 gms. Aq. solvent | Gms. $C_6H_5CONHC_6H_5$ dissolved per 100 gms. solvent at: | | | |
|---|---|---|---|---|
| | 20° | 25° | 30° | 35° |
| 0.0 (= $H_2O$) | Almost insoluble | | | |
| 52.4 | 0.13 | — | — | — |
| 76.8 | 0.61 | 0.79 | 1.00 | 1.22 |
| 85.0 | 1.11 | 1.37 | 1.69 | 2.07 |
| 91.3 | 1.60 | 1.92 | 2.31 | 2.77 |
| 99.0 | 1.73 | 2.09 | 2.54 | 3.10 |

Freezing-point data are given for mixtures of benzanilide and:

Benzil (Van stone, 1913.)
Benzoin " "
Benzylidene aniline (Van stone, 1913.)
Veronal (Pfeiffer and Angern, 1926.)

Results for mixtures of o and p chloro benzanilide are given by King and Orton, 1911.

**AMINO BENZOPHENONE** $C_6H_5COC_6H_4NH_2$.

Freezing-point data for mixtures of amino benzo phenone and p amino azobenzene are given by Erlenmeyer and Leo, 1933.

**DIPHENYL METHANE** $CH_2(C_6H_5)_2$.

Freezing-point data are given for mixtures of Diphenyl methane and:

Diphenyl amine(1)
" ether(1)
Hydroquinone(3)
Naphthols(3)
Naphthalene(4)
Naphthylamines(3)
Phenol(5)
Phenylene diamine(3)
Pyrocatechol(3)
Pyrogallol(3)
Picric acid(2)(3)
Resorcinol(3)
Styphnic acid(2)

(1) Grimm, Gunther and Titus, 1931; (2) Jefremow, 1918; (3) Kremann and Fritsch, 1920; (4) Miolati, 1892; (5) Paterno and Ampola, 1897.

**4-METHYL AZOBENZENE** $CH_3C_6H_4N{:}NC_6H_5$.

Freezing-point data for mixtures of 4-methyl azobenzene and 4-chlor azobenzene are given by Grimm, Gunther and Titus, 1931.

**BENZOHYDROL** (Diphenyl carbinol) $(C_6H_5)_2CHOH$

Freezing-point data are given for mixtures of Benzohydrol and:

| | | |
|---|---|---|
| Benzene(3) | Naphthols(2) | Picric acid(2) |
| Benzophenone(1) | Naphthylamines(2) | Phenylene diamines(2) |
| Dimethyl aniline(3) | Nitrophenols(2) | Pyrocatechol(2) |
| Dinitro phenol(2) | Phenol(2)(3) | Pyrogallol(2) |
| Hydroquinone(2) | " α naphthyl acetone(1) | Resorcinol(2) |

(1) Boeseken, 1921; (2) Kremann and Drazil, 1924; (3) Schmidlin and Lang, 1912.

**BENZYL PHENOL** $C_6H_5CH_2C_6H_4OH$.

Freezing-point data for mixtures of benzyl phenol with bibenzyl and with benzylaniline are given by Pascal and Normand, 1913.

**DIPHENYL UREA** $CO.(NHC_6H_5)_2$.

100 gms. $H_2O$ dissolve 0.015 gm. diphenyl urea (sym or uns.?) at 20–25°.
" pyridine dissolve 6.85 gms. diphenyl urea (sym or uns.?) at 20–25°.
" aq. 50% pyridine dissolve 5.3 gms. diphenyl urea (sym or uns.?) at 20–25°. (Dehn, 1917.)

SOLUBILITY OF SYMETRICAL AND OF ASYMETRICAL DIPHENYL UREA IN SEVERAL SOLVENTS.

| Solvent | t° | Gms. per 100 gms. solvent: $CO(NHC_6H_5)_2$ (1) | Gms. per 100 gms. solvent: $NH_2CON(C_6H_5)_2$ (2) |
|---|---|---|---|
| Abs. alcohol | 20-25 | 0.84 | — |
| Quinoline | " | 2.50 | — |
| Alcohol + Quinoline | " | 3.12 | — |
| Chloroform | " | 0.07 | 8.33 (20°) |
| Carbon tetrachloride | 20 | — | 1.56 |

(1) Pucher and Dehn, 1921; (2) Pawlewski, 1914, 1926.

Benzoyl **PHENYL HYDRAZINE** $C_6H_5NH.NHC_7H_5O$.

SOLUBILITY IN AQUEOUS ALCOHOL AT 25°.
(Holleman and Antusch, 1894.)

| Vol. % Alcohol. | Gms. Hydrazine per 100 g. Solvent. | Sp. Gr. Solutions. | Vol. % Alcohol. | Gms. Hydrazine per 100 g. Solvent. | Sp. Gr. Solutions. |
|---|---|---|---|---|---|
| 100 | 2.39 | 0.793 | 80 | 1.59 | 0.859 |
| 95 | 2.43 | 0.814 | 70 | 1.08 | 0.884 |
| 93 | 3 | 0.822 | 55 | 0.51 | 0.917 |
| 90 | 2.26 | 0.831 | 40 | 0.16 | 0.946 |

The above results give an irregular curve. See remarks under α acetnaphthalide, p. 705

**BENZYL ANILINE** $C_6H_5CH_2C_6H_4NH_2$.

Freezing-point data are given by Pascal and Normand, 1913, for mixtures of benzyl aniline and each of the following compounds: Azobenzene, benzal aniline, dibenzyl, hydrazo benzene, benzyl phenol, phenyl benzyl ether, stilbene and tolane. Results for mixtures of benzyl aniline and azobenzene are also given by Beck, 1904, Isaac, 1910-11, Jaeger, 1907, and Hasselblatt, 1913.

**DIPHENYL GUANIDINE** $NH:C-[NHC_6H_5]_2$.

Determinations of the solubility of diphenyl guanidine and of other compounds in rubber by means of the microscopic examination of thin sheets of samples prepared in a laboratory mill are described by Morris, 1932.

Freezing-point data for mixtures of diphenyl guanidine and benzothiazol are given by Minatoya, Kojima and Nogai, 1931.

**PHENYL p TOLYL AMINE** $(C_6H_5)(C_7H_7)NH$.

Freezing-point data for mixtures of phenyl p tolyl amine and di p tolyl amine are given by Chapman and Perrott, 1930.

**p TOLUENE SULPHONE ANILIDE** $CH_3C_6H_4SO_2.NHC_6H_5$.

SOLUBILITY OF p TOLUENE SULFONE ANILIDE IN AQUEOUS SOLUTIONS OF ACETIC ACID.
(Bradfield and Williams, 1929.)

See Benzanilide p. 725.

| Gms. $CH_3COOH$ per 100 gms. aqueous solvent | Gms. $CH_3C_6H_4SO_2.NHC_6H_5$ dissolved per 100 gms. solvent at: | | | |
|---|---|---|---|---|
| | 20° | 25° | 30° | 35° |
| 0.0 (= $H_2O$) | Almost insoluble | | | |
| 26.9 | 0.09 | — | — | — |
| 52.4 | 0.88 | 1.02 | 1.24 | 1.60 |
| 76.8 | 6.2 | 7.5 | 9.7 | 12.6 |
| 85.0 | 11.0 | 13.2 | 16.7 | 21.6 |
| 91.3 | 15.9 | 19.4 | 24.6 | 31.7 |
| 99.0 | 22.0 | 26.1 | 32.5 | 42.1 |

Sym. **DIPHENYL CARBAZIDE** (carbohydrazide) $1,5-(C_6H_5NHNH)_2CO$.

Freezing-point data are given for mixtures of s diphenyl carbazide and 1-phenyl semicarbazide by Sswetlow, 1933.

Freezing-point data are given for mixtures of sym. diphenyl carbazide and 1-phenyl semi carbazide by Noller, 1930.

**ACETYL AMINO ANTIPYRINE** $C_3N_2O(NHCOCH_3)C_6H_5(CH_3)_2$.

Freezing-point data are given for mixtures of acetyl methyl antipyrine and:

n Methyl phenyl voluntal (Pfeiffer and Seydel , 1928.)
n Phenyl voluntal " " " "
Veronal (C-Diethyl barbituric acid)(Pfeiffer and Angern, 1926.)
Voluntal (carbaminic acid tri chlor ethyl ester)(Pfeiffer and Angern, 1926.)

**PYRAMIDON** (Dimethyl amino antipyrine; 1-phenyl, 2,3-dimethyl, 4-dimethyl amine, 5-pyrazolone) $(C_{11}H_{11}ON_2)N(CH_3)_2$.

SOLUBILITY OF PYRAMIDON IN WATER.
(Charonnat, 1927.)

The curve representing the solubility of pyramidon in water is quite unusual in that at temperatures above 65° the system separates into two liquid phases of which the curve of demarcation is a complete circle.

| $t^o$ | Gms. $(C_{11}H_{11}ON_2)N(CH_3)_2$ per 100 gms. sat. sol. | Solid Phase | Results for the liquid layers $t^o$ lower | $t^o$ upper | Gms. $(C_{11}H_{11}ON_2)N(CH_3)_2$ per 100 gms. sat. sol. |
|---|---|---|---|---|---|
| 0 | 6.54 | $(C_{11}H_{11}ON_2)N(CH_3)_2$ | 123 | 123 | 9.38 |
| 20 | 5.3 | " | 104 | 129 | 10.0 |
| 37 | 5.3 | " | 81 | 166 | 15 |
| 55 | 7.9 | " | 77.5 | 175 | 20 |
| 65 | 13.0 | " | 70.5 | 183 | 27 |
| 70 | 40.0 | "+liquid phase | 70 | 190 | 40 |
| 69.5 | 50.0 | "+ " " | 70 | 190 | 45 |
| 74 | 75 | " | 69.5 | 188 | 50 |
| 90 | 94 | " | 74.4 | 175 | 66.6 |
| 108(m.pt.) | 100 | " | 84 | 152 | 75 |
| | | | 92 | 138 | 77.7 |
| | | | 115 | 115 | 79.5 |

Due to the peculiar solubility of pyramidon in water it will be noted, for instance, that when a mixture of one part of pyramidon and 9 parts of water, which forms a saturated solution at about 60°, is heated in a sealed tube, it becomes cloudy at about 100° and becomes clear again at about 130°. On cooling, the reversephenomena occurs and crystals separate only when the temperature decreases to about 60°. This solution is therefore saturated at three different temperatures. A solution of somewhat lower concentration is, however, saturated at only one temperature.

**PYRAMIDON**

Freezing-point data are given for mixtures of pyramidon and:

Acetanilide(1)
o Amino phenol(7)
Barbital(2)(4)
Benzimidazole(3)
Bromural(9)
Butyl chloraldehyde(5)
Cholesterol(5)
Ethyl carbamate(5)
Luminal(6)
Methyl amino benzoate(7)
" barbituric acid(6)
" p oxy benzoate(7)
" phenyl voluntal(5)
" veronal(6)
Orthoform neu(7)
Phenacetine(1)
Ph
Pheno barbital(Luminal(6)
Phenyl urethan(5)
" veronal(6)
" voluntal(5)
Tri chlor ethyl carbamate(Voluntal(5)
Urethan(5)
Veronal(c Diethyl barbituric acid(2)(8)

(1) Angeletti, 1927; (2) Pfeiffer, 1925; (3) Pfeiffer and Angern, 1926; (4) Pfeiffer and Ochiai, 1932; (5) Pfeiffer and Seydel, 1928; (6) Pfeiffer and Seydel, 1928a; (7) Pfeiffer and Seydel, 1928b; (89 Rheinboldt and Kirscheisen, 1925; (9) Sandquist and Hök, 1927.

**SALICIN** $C_6H_4(CH_2.OH)O.C_6H_{11}O_5$.

Solubility in Several Solvents.

| Solvent. | t°. | Gms. per 100 Gms. Solvent. | Authority. |
|---|---|---|---|
| Water | 15 | 3.52 | (Greenish and Smith, 1903.) |
| Water | 25 | 4.16 | (Dott, 1907.) |
| 90% Alcohol | 15 | 1.5 | (Greenish and Smith, 1903.) |
| 90% Alcohol | 15 | 2 | (Squire and Caines, 1905.) |
| Trichlor Ethylene | 15 | 0.013 | (Wester and Bruins, 1914.) |

**NOVOCAINE** (base) $CH_2(C_6H_4NH_2COO)CH_2[N.(C_2H_5)_2].2H_2O$.

100 cc. $H_2O$ dissolve 0.333 gm. anhydrous novocaine at 20°. (Zalai, 1910.)
100 cc. oil of sesame dissolve 4.29 gms. anhydrous novocaine at 20°.

Determinations of the dissociation constants, solubilities in water and distribution coefficients between water and ether of Novocaine, $NH_2C_6H_4COO.CH_2.CH_2N(C_2H_5)_2$, and of Pantocaine, $NH(C_4H_9)C_6H_4COO.CH_2.CH_2.CH_2N(CH_3)_2$, are described by Eisenbrand and Pitcher, 1938. The solubility of these compounds in water depends upon the hydrogen ion concentration of the solution. The dissociation constants show that Novocaine is completely undissociated at pH10 and Pantocaine at pH9. The solubilities at these hydrogen ion concentrations were found to be:

0.013 gm. Novocaine per 100 cc $H_2O$ at ? t°.
0.0156 " Pantocaine " " " " " " "

**NOVOCAINE** (Hydrochloride) $CH_2(C_6H_4NH_2COO).CH_2[N(C_2H_5)_2].HCl$.

100 gms. $H_2O$ dissolve about 100 gms. of the salt at room temp.
100 gms. alcohol dissolve about 3 gms. of the salt at room temp.

**NOVOCAINE** Bichromate $(C_{13}H_{20}O_2N_2)_2.H_2Cr_2O_7$.

SOLUBILITY OF NOVOCAINE BICHROMATE IN WATER.
(Bungenburg, de Jong and Holleman, 1937.)

In this system separation into two liquid layers occurs at 74°, between the concentrations 9 and 74 percent salt. The determinations were made by the sealed tube method (thermic analysis) and the results are given in the form of a diagram from which the following approximate values were read.

| t° | Gms. $(C_{13}H_{20}O_2N_2)_2.H_2Cr_2O_7$ per 100 gms. sat. sol. | Solid Phase |
|---|---|---|
| 63 | 2.0 | $(C_{13}H_{20}O_2N_2)_2.H_2Cr_2O_7$ |
| 70 | 3.0 | " |
| 74 | 9.0 | " + liquid |
| 74 | 74.0 | " " |
| 80 | 79 | " |
| 90 | 82.5 | " |
| 100 | 90.0 | " |
| 120 | 97.5 | " |
| 133 | m.pt. 100 | " |

Results for the liquid layers

| t° | Gms. $(C_{13}H_{20}O_2N_2)_2.H_2Cr_2O_7$ per 100 gms. sat. sol. |
|---|---|
| 80 | 11 |
| 90 | 18 |
| 95 | 22 |
| 98 | Crit. t. 40 |
| 97 | 50 |
| 92.5 | 60 |
| 90 | 62.5 |
| 80 | 71 |
| 74 | 74 + solid |

**ELAIDIC ACID** $C_8H_{17}CH:CH(CH_2)_2COOH$.

SOLUBILITY OF ELAIDIC ACID IN SEVERAL SOLVENTS. (Lebrun, 1925.)

| Solvent. | t°. | Gms. $C_{18}H_{34}O_2$ per 100 gms. solvent. |
|---|---|---|
| Acetylene dichloride (trans) (b. pt. 48°.3) | 0 | 10.97 |
| » » (cis) (b. pt. 60°.2) | 0 | 6.20 |
| Ethyl chlorisocrotonate | 24 | 47.7 |
| Crotonic nitrile (b. p. 107°.7–108°.2) | 25 | 17.45 |
| » » (b. pt. 121°.8–122°.3) | 25 | 12.33 |
| Bromo butene (b. pt. 93°.9) | 0 | 3.68 |
| » » (b. pt. 85°.5–85°.6) | 0 | 4.10 |

**n DECYL MALONIC ACID** $C_{10}H_{21}CH(COOH)_2$.

100 gms $H_2O$ dissolve 0.0025 gm. $C_{10}H_{21}CH(COOH)_2$ at 25°. (Verkade and Coops, Jr., 1930a.)

**ETHYL AZELATE** $(CH_2)_7(COOC_2H_5)_2$.

100 cc $H_2O$ dissolve 0.025 gm. $(CH_2)_7(COOC_2H_5)_2$ at 20°. (Sobotka and Kahn, 1931.)

**MYRISTIC ACID** $C_{13}H_{27}COOH$.

SOLUBILITY IN ALCOHOLS. (Timofeiew, 1894.)

| Alcohol. | t°. | Gms. $C_{13}H_{27}COOH$ per 100 Gms. Sat. Sol. | Alcohol. | t°. | Gms. $C_{13}H_{27}COOH$ per 100 Gms. Sat. Sol. |
|---|---|---|---|---|---|
| Methyl Alcohol | 0 | 2.81 | Propyl Alcohol | 0 | 5.6 |
| " " | 21 | 21.2 | " " | 21 | 31.2 |
| " " | 31.5 | 59.2 | " " | 36.5 | 55.3 |
| Ethyl Alcohol | 0 | 7.14 | Isobutyl Alcohol | 0 | 6.4 |
| " " | 21 | 31 | " " | 21 | 28 |

Freezing-point data for myristic acid + palmitic acid are given by Heintz (1854).

**BENZOTHIAZOLE DISULFIDE** $C_{14}H_8N_2S_4$.

Determinations of the solubility of Benzothiazole disulfide of Mercapto benzothiazole and of other compounds in rubber by means of the microscopic examination of thin sheets of samples prepared in a laboratory mill, are described by Morris, 1932.

**CHLORO ANTHRAQUINONES** (Mono and Di) $C_{14}H_7ClO_2$, $C_{14}H_6Cl_2O_2$.

Freezing-point data for mixtures mono and dichloro anthraquinones are given by Coppens, 1925, and by Lauer, 1931.

**ANTHRAQUINONE** $(C_6H_4)_2(CO)_2$.

SOLUBILITY IN LIQUID SULFUR DIOXIDE IN THE CRITICAL REGION.

(Centnerswer and Teletow 1903.) (See Anthracene, p. 738.)

| t°. | Gms. $C_{14}H_8O_2$ per 100 Gms. $SO_2$. | t°. | Gms. $C_{14}H_8O_2$ per 100 Gms. $SO_2$. | t°. | Gms. $C_{14}H_8O_2$ per 100 Gms. $SO_2$. |
|---|---|---|---|---|---|
| 3.96 | 0.64 | 92.1 | 2.81 | 118.5 | 5.60 |
| 51.5 | 0.88 | 101.4 | 3.67 | 141.6 | 7.53 |
| 67.9 | 1.73 | 106.3 | 4.23 | 160 | 9.60 |
| 82.4 | 2.24 | 108.7 | 4.40 | 179 | 12.70 |
| | | | | 183.7 | 18.30 |

100 parts of absolute ethyl alcohol dissolve 0.05 part anthraquinone at 18° and 2.249 parts at b. pt. (v. Becchi.)

100 gms. alcohol dissolve 0.437 gm. anthraquinone at 25°. (Hildebrand, Ellefson and Beebe, 1917.)

SOLUBILITY OF ANTHRAQUINONE IN BENZENE AND IN CHLOROFORM.

(Tyrer, 1910.)

| | In Benzene. | | | In Chloroform. | |
|---|---|---|---|---|---|
| t°. | Sp. Gr. Solution. | Gms. $C_{14}H_8O_2$ per 100 Gms. $C_6H_6$. | t°. | Sp. Gr. Solution. | Gms. $C_{14}H_8O_2$ per 100 Gms. $CHCl_3$. |
| 0 | 0.8900 | 0.110 | 0 | 1.5244 | 0.340 |
| 20 | 0.8794 | 0.256 | 10 | 1.5046 | 0.457 |
| 30 | 0.8692 | 0.350 | 20 | 1.4850 | 0.605 |
| 40 | 0.8591 | 0.495 | 30 | 1.4656 | 0.780 |
| 50 | 0.8439 | 0.700 | 40 | 1.4461 | 0.994 |
| 60 | 0.8389 | 0.974 | 50 | 1.4261 | 1.256 |
| 70 | 0.8288 | 1.355 | 55 | 1.4164 | 1.415 |
| 80 | 0.8190 | 1.775 | 60 | 1.4070 | 1.577 |

SOLUBILITY OF ANTHRAQUINONE IN A MIXTURE OF CHLOROFORM AND HEXANE AT 12.6° AND 49°.

(Tyrer, 1910, also private communication. See Note, p. 735.)

| % $CHCl_3$ in Solvent. | Gms. $C_{14}H_8O_2$ per 100 Gms. Solvent at: | | % $CHCl_3$ in Solvent. | Gms. $C_{14}H_8O_2$ per 100 Gms. Solvent at: | |
|---|---|---|---|---|---|
| | 12.6°. | 49.0°. | | 12.6°. | 49.0°. |
| 0 | 0.006 | 0.056 | 60 | 0.101 | 0.292 |
| 10 | 0.016 | 0.074 | 70 | 0.148 | 0.417 |
| 20 | 0.024 | 0.096 | 80 | 0.222 | 0.608 |
| 30 | 0.034 | 0.124 | 90 | 0.334 | 0.852 |
| 50 | 0.068 | 0.212 | 100 | 0.482 | 1.209 |

## Solubility of Anthraquinone in Ether.

(Smits — Z. Electrochem. 9, 663, '03.)

Weighed amounts of ether and anthraquinone were placed in glass tubes which were then sealed. The temperature noted at which the anthraquinone disappeared and also at which the liquid phase disappeared (critical temp.). The two curves cross at 195° and again at 241°. Between these two temperatures the critical curve lies below the solubility curve, hence for this range of temperature no solubility curve is shown. The following figures were read from the curves, and are therefore only approximately correct.

| t°. | Gms. $C_{14}H_8O_2$ per 100 g. Solution. | t°. | Gms. $C_{14}H_8O_2$ per 100 g. Solution. | t° | Gms. $C_{14}H_8O_2$ per 100 g. Solution. |
|---|---|---|---|---|---|
| 130 | 3 | 241 | 30 | 260 | 80 |
| 150 | 4 | 245 | 40 | 270 | 90 |
| 170 | 4·5 | 247 | 50 | 275 | 100 |
| 195 | 5·0 | 250 | 60 | | |

100 parts of toluene dissolve 0.19 part anthraquinone at 15° and 5.56 parts at 100° (v. Becchi).

100 gms. ether dissolve 0 104 gm. anthraquinone at 25°.

(Hildebrand, Ellefson and Beebe, 1917.)

Data for the solubility of anthraquinone in mixtures of phenol and water are given by Timmermanns (1907).

100 gms. carbon tetrachloride dissolve 0,043 gm. $C_6H_4(CO)_2C_6H_4$ at 20° } (Pawlewski, 1914, 1926.)
» » chloroform » 0,54 » » » » }

## Solubility of Anthraquinone in Mixtures of Solvents at 17°.95.

(Joscht, 1914, 1926.)

### Results for Mixtures of Carbon Tetrachloride and :

| Acetone $CCl_4 + CH_3COCH_3$. | | Benzene $CCl_4 + C_6H_6$. | | Chloroform $CCl_4 + CHCl_3$. | | Ethylacetate $CCl_4 + CH_3COOC_2H_5$ | |
|---|---|---|---|---|---|---|---|
| Gms. $CCl_4$ per 100 gms. of mixture. | Gms. $C_{14}H_8O_2$ per 100 gms. solvent. | Gms. $CCl_4$ per 100 gms. of mixture. | Gms. $C_{14}H_8O_2$ per 100 gms. solvent. | Gms. $CCl_4$ per 100 gms. of mixture. | Gms. $C_{14}H_8O_2$ per 100 gms. solvent. | Gms. $CCl_4$ per 100 gms. of mixture. | Gms. $C_{14}H_8O_2$ per 100 gms. solvent. |
| 97.46 | 0.059 | 100.0 | 0.043 | 100.0 | 0.043 | 100.0 | 0.043 |
| 95.0 | 0.072 | 90.0 | 0.060 | 90.0 | 0.072 | 90.0 | 0.065 |
| 90.0 | 0.089 | 80.0 | 0.071 | 80.0 | 0.097 | 80.0 | 0.087 |
| 80.0 | 0.115 | 70.0 | 0.095 | 70.0 | 0.139 | 70.0 | 0.089 |
| 70.0 | 0.128 | 64.44 | 0.105 | 60.0 | 0.183 | 60.0 | 0.097 |
| 66.8 | 0.122 | 60.0 | 0.108 | 57.74 | 0.215 | 55.8 | 0.095 |
| 60.0 | 0.130 | 50.0 | 0.128 | 50.0 | 0.231 | 50.0 | 0.111 |
| 50.0 | 0.131 | 40.0 | 0.157 | 40.0 | 0.285 | 40.0 | 0.117 |
| 30.0 | 0.133 | 30.0 | 0.174 | 30.0 | 0.341 | 30.0 | 0 115 |
| 20.0 | 0.127 | 20.0 | 0.185 | 20.0 | 0.408 | 20.0 | 0.115 |
| 10.0 | 0.126 | 10.0 | 0.200 | 10.0 | 0.472 | 10.0 | 0.129 |
| 0.0 | 0.121 | 0.0 | 0.225 | 0.0 | 0.542 | 0.0 | 0.120 |

## Results for Mixtures of :

| $CHCl_3 + CH_3COCH_3$. | | $CHCl_3 + C_6H_6$. | | $CHCl_3 + CH_3COOC_2H_5$. | | $C_6H_6 + CH_3COOC_2H_5$. | |
|---|---|---|---|---|---|---|---|
| Gms. $CHCl_3$ per 100 gms. of mixture. | Gms. $C_{14}H_8O_2$ per 100 gms. solvent. | Gms. $CHCl_3$ per 100 gms. of mixture. | Gms. $C_{14}H_8O_2$ per 100 gms. solvent. | Gms. $CHCl_3$ per 100 gms. of mixture. | Gms. $C_{14}H_8O_2$ per 100 gms. solvent. | Gms. $C_6H_6$ per 100 gms. of mixture. | Gms. $C_{14}H_8O_2$ per 100 gms. solvent. |
| 0.0 | 0.121 | 0.0 | 0.223 | 0.0 | 0.120 | 0.0 | 0.121 |
| 10 | 0.121 | 10 | 0.218 | 10.0 | 0.113 | 10 | 0.132 |
| 20 | 0.117 | 20 | 0.236 | 20.0 | 0.114 | 20 | 0.150 |
| 30 | 0.117 | 30 | 0.244 | 30.0 | 0.097 | 30 | 0.166 |
| 40 | 0.111 | 40 | 0.244 | 40.0 | 0.106 | 40 | 0.176 |
| 50 | 0.115 | 45.9 | 0.249 | 50.0 | 0.104 | 50 | 0.184 |
| 60 | 0.123 | 50 | 0.263 | 54.1 | 0.100 | 52.6 | 0.190 |
| 65.32 | 0.121 | 60 | 0.287 | 60.0 | 0.119 | 60 | 0.206 |
| 70 | 0.137 | 70 | 0.325 | 70.0 | 0.142 | 70 | 0.230 |
| 80 | 0.177 | 80 | 0.365 | 90.0 | 0.304 | 80 | 0.232 |
| 90 | 0.276 | 90 | 0.437 | 95.0 | 0.357 | 90 | 0 244 |
| 95 | 0.328 | 100 | 0.542 | 100.0 | 0.542 | 100 | 0.223 |

## Solubility of Anthraquinone at 25° in Mixtures of:

(Mahieu, 1936.)

| Methyl Alcohol + Chloroform | | Chloroform and Benzene | |
|---|---|---|---|
| Gms. $CHCl_3$(1) per 100 gms. $CHCl_3 + CH_3OH$ | Gms. $C_{14}H_8O_2$ per 100 gms. Solvent | Gms. $C_6H_6$ per 100 gms. $C_6H_6 + CHCl_3$ | Gms. $C_{14}H_8O_2$ per 100 gms. Solvent |
| -0.0 | 0.707 | 0.0 | 0.707 |
| 10.4 | 0.88 | 25.9 | 0.437 |
| 16.4 | 1.73 | 52.1 | 0.415 |
| 25.8 | 1.54 | 74.4 | 0.425 |
| 26.2 | 0.92 | 100.0 | 0.470 |
| 49.2 | 0.305 | | |
| 73.6 | 0.437 | | |
| 100.0 | 0.400 | | |

(1) This is evidently an error in the original paper and should be $CH_3OH$

## Solubility of Amino and Other Anthraquinones in Absolute Ethyl Alcohol at 60°

(Kartsschoff and Farine, 1928.)

| Compound | Formula | Gms. Compound per liter sat. sol. |
|---|---|---|
| 1-Amino Anthraquinone | $C_6H_4(CO)_2C_6H_3NH_2$ | 3.51 |
| 1,4-Diamino " | $NH_2C_6H_3(CO)_2C_6H_3NH_2$ | 5.54 |
| 1,5- " " | " | 6.85 |
| 1,8- " " | " | 6.82 |
| 1,4,5,8-Tetraamino Anthraquinone | $(NH_2)_2C_6H_2(CO)_2C_6H_2(NH_2)_2$ | 1.84 |
| 1,2-Dioxy " (Alizarine) | $C_6H_4(CO)_2C_6H_2(OH)_2$ | 3.70 |
| 1,2,4-Tri oxy " (Purpurine) | $C_6H_4(CO)_2C_6H(OH)_3$ | 8.61 |
| 1-Oxy,4-Amino " | $C_6H_4(CO)_2C_6H_2(OH)(NH_2)$ | 5.14 |
| 1-Oxy,4-8-diamino " (Anthrarufine) | $NH_2C_6H_3(CO)_2C_6H_2(OH)(NH_2)$ | 1.06 |
| 1-Methyl amino " | $C_6H_4(CO)_2C_6H_3(NHCH_3)$ | 14.96 |
| 1-amino,2-methyl " | $C_6H_4(CO)_2C_6H_2(NH_2)(CH_3)$ | 5.88 |
| 1-amino,4-anilido " | $C_6H_4(CO)_2C_6H_2(NH_2)(NHC_6H_5)$ | 6.57 |
| 1-amino,4-toluido " | $C_6H_4(CO)_2C_6H_2(NH_2)(NHC_6H_4CH_3)$ | 0.47 |
| 1,4 ditoluido " | $C_6H_4(CO)_2C_6H_2(NHC_6H_4CH_3)_2$ | 0.34 |
| 1,4 " 2-methyl " | $C_6H_4(CO_2C_6H(NHC_6H_4CH_3)_2(CH_3)$ | 2.25 |

Experiments on the distribution of these compounds between alcohol and cellulose acetate silk are also given and explanations deduced in regard to the dying of acetate silk.

## ANTHRAQUINONES

### Solubility of Anthraquinone Sulfonic Acids in Water at 18°.
(Fierz-David, Krebser and Anderau, 1927.).

| Compound | Formula | Gms. Compound per 100cc $H_2O$ |
|---|---|---|
| 1.5-Anthraquinone disulfonic acid | $C_{14}H_6O_2(SO_3H)_2.4\ H_2O$ | 66.6 |
| 1.8 " " " | " .5 $H_2O$ | 66.6 |
| 1.6 " " " | " .5 $H_2O$ | 100.0 |
| 1.5 " chloro sulfonic acid | $C_{14}H_6O_2ClSO_3H.4H_2O$ | 50.0 |
| 1.6 " " " " | " .$3H_2O$ | 25.0 |
| 1.7 " " " " | " .$3H_2O$ | 25.0 |

These authors also give the solubilities in water of inorganic salts of the above and other anthraquinone sulfonic acids. (See Vol. 1)

Hydroxy **ANTHRAQUINONES** $C_6H_4 < (CO)_2 > C_6H_3OH$.

1000 cc. $H_2O$ dissolve 0.0035 gm. $\alpha$ oxyanthraquinone at 25°. (Hüttig, 1914.)
1000 cc. $H_2O$ dissolve 0.0011 gm. $\beta$ oxyanthraquinone at 25°. "
1000 cc. $H_2O$ dissolve 0.000012–0.000062 gm. 1.4 dioxyanthraquinone (= chinizarin) at 25°.
1000 cc. $H_2O$ dissolve 0.00158 gm. 1.6 dioxyanthraquinone (= chrysazin) at 25°. (Hüttig, 1914.)

**ANTHRAFLAVINE** (2.6 Dioxyanthraquinone) $C_{12}H_6(CO)_2(OH)_2$.

1000 cc. $H_2O$ dissolve 0.0003 gm. anthraflavine at 25°. (Hüttig, 1914.)

**ANTHRARUFINE** (1.5 Dioxyanthraquinone) $C_{12}H_6(CO)_2(OH)_2$.

1000 cc. $H_2O$ dissolve 0.000285 gm. anthrarufine at 25°. (Hüttig, 1914.)

Trioxy methyl**ANTHRAQUINONE** (Emodin) $C_{15}H_{10}O_5$.

### Solubility in Several Solvents. (Beal and Katti, 1925.)

The saturated solutions were prepared by boiling an excess of the compound with the solvent, allowing to stand at room temperature and filtering.

| Solvent. | Gms. Emodin per 100 cc. sat. sol. | Solvent. | Gms. Emodin per 100 cc. sat. sol. |
|---|---|---|---|
| Benzene..... | 0.0405 | Chloroform..... | 0.0705 |
| Carbon tetra chloride.. | 0.0102 | Ether..... | 0.1400 |
| Carbon disulfide..... | 0.0088 | | |

**PHENANTHRAQUINONE** $C_6H_4\underbrace{COCO}C_6H_4$.

### Solubility of Phenanthraquinone in Aqueous Solutions of Acids at 25°.
(Knox and Will, 1919.)

The determinations were made by shaking a weighed amount of phenanthraquinone with 200 cc. of solvent untill saturation was complete, and then filtering, drying and weighing the undissolved residue of phenanthraquinone.

Solubility in Aqueous Sulfuric Acid. Gm. equivalents per liter.

| $H_2SO_4$. | $C_{14}H_8O_2$. |
|---|---|
| 0.0 | 0.0075 |
| 5.97 | 0.0080 |
| 6.19 | 0.0085 |
| 7.00 | 0.0095 |
| 9.48 | 0.012 |
| 11.6 | 0.019 |
| 13.7 | 0.030 |
| 15.1 | 0.043 |
| 17.1 | 0.080 |
| 18.6 | 0.116 |

Solubility in Aqueous Hydrochloric Acid. Gm. equivalents per liter.

| HCl. | $C_{14}H_8O_2$. |
|---|---|
| 0.0 | 0.0075 |
| 3.11 | 0.012 |
| 4.25 | 0.016 |
| 5.12 | 0.023 |
| 6.05 | 0.029 |
| 6.07 | 0.031 |
| 7.20 | 0.046 |
| 8.50 | 0.058 |
| 9.25 | 0.088 |
| 10.8 | 0.157 |

Solubility in Aqueous Nitric Acid. Gm. equivalents per liter.

| $HNO_3$. | $C_{14}H_8O_2$. |
|---|---|
| 0.0 | 0.0075 |
| 4.26 | 0.049 |
| 4.54 | 0.053 |
| 5.02 | 0.067 |
| 6.15 | 0.099 |
| 6.66 | 0.114 |
| 6.70 | 0.118 |
| 7.20 | 0.157 |
| 7.45 | 0.175 |
| 8.30 | 0.227 |

$C_{14}H_8O_4$

**PHENANTHRAQUINONE** $C_6H_4CO_2CO_2C_6H_4$.

SOLUBILITY IN BENZENE AND IN ETHYL ACETATE.

(Tyrer, 1910.)

| Solubility in Benzene. | | | Solubility in Ethyl Acetate. | | |
|---|---|---|---|---|---|
| t°. | Sp. Gr. of Sat. Solution. | Gms. $(C_6H_4)_2(CO_2)_2$ per 100 Gms. Benzene. | t°. | Sp. Gr. of Sat. Solution. | Gms. $(C_6H_4)_2(CO_2)_2$ per 100 Gms Ethyl Acetate. |
| 10 | 0.8902 | 0.412 | 10 | 0.9102 | 0.518 |
| 15 | 0.8850 | 0.471 | 20 | 0.9025 | 0.626 |
| 20 | 0.8800 | 0.538 | 30 | 0.8906 | 0.770 |
| 30 | 0.8698 | 0.738 | 40 | 0.8789 | 0.995 |
| 40 | 0.8601 | 1.032 | 50 | 0.8674 | 1.292 |
| 50 | 0.8506 | 1.354 | 60 | 0.8561 | 1.640 |
| 60 | 0.8415 | 1.760 | 65 | 0.8508 | 1.902 |
| 70 | 0.8327 | 2.687 | 70 | 0.8454 | 2.215 |
| 80 | 0.8241 | 3.770 | 75 | 0.8401 | 2.515 |

NOTE. — The Sp. Gr. determinations given in the above table and in the tables for anthracene, p. 737 and anthraquinone, p 731 are not included in the original paper of Tyrer (1910) but, in response to my request, have been kindly supplied for the present volume. I am also indebted to Dr. Tyrer for the modified form of his original tables showing the solubilities of anthraquinone and phenanthraquinone in mixed solvents. (A. S.)

SOLUBILITY OF PHENANTHRAQUINONE IN MIXTURES OF ORGANIC SOLVENTS.

(Tyrer, 1910.)

| In $C_6H_6$ + Hydrocarbons (1) at 48°. | | In $CHCl_3$ + Pentane at 14.5°. | | In $CH_3COOC_2H_5$ + Hydrocarbons(1) at 48°. | |
|---|---|---|---|---|---|
| Per cent $C_6H_6$ in Mixed Solvent | Gms. Phenanthraquinone per 100 Gms. Solvent. | Per cent $CHCl_3$ in Mixed Solvent. | Gms. Phenanthraquinone per 100 Gms. Solvent. | Per cent $CH_3COOC_2H_5$ in Mixed Solvent. | Gms. Phenanthraquinone per 100 Gms. Solvent. |
| 0 | 0.0708 | 0 | 0.025 | 0 | 0.073 |
| 10 | 0.088 | 10 | 0.045 | 14.19 | 0.126 |
| 20 | 0.118 | 20 | 0.080 | 27.37 | 0.207 |
| 30 | 0.160 | 30 | 0.115 | 39.94 | 0.335 |
| 40 | 0.228 | 40 | 0.165 | 52.12 | 0.494 |
| 50 | 0.318 | 50 | 0.220 | 63.56 | 0.656 |
| 60 | 0.440 | 60 | 0.330 | 74.19 | 0.817 |
| 70 | 0.588 | 70 | 0.525 | 84.62 | 0.993 |
| 80 | 0.772 | 80 | 0.805 | 90 | 1.073 |
| 90 | 1.004 | 90 | 1.415 | 100 | 1.230 |
| 100 | 1.288 | 100 | 2.402 | | |

(1) Distilled from petroleum, b. pt. = 82°-92°. (See note, above.)

**ALIZARIN** (1.2 Dioxyanthraquinone) $C_{14}H_6O_2(OH)_2$.

SOLUBILITY IN WATER AT VARYING TEMPERATURES.
(Hüttig, 1914; Beilstein.)

| t°. | 25° | 100°. | 250°. |
|---|---|---|---|
| Grams Alizarin per liter | 0.000595 | 0.340 | 3.017 |

According to Dehn (1917), 100 gms. $H_2O$ dissolve 0.04 gm. alizarin at 20°–25°.

SOLUBILITY OF ALIZARIN IN AQUEOUS SOLUTIONS OF:

| Ammonia at 25°. | | Sodium Hydroxide at 25° (Hüttig, 1914.) | | |
|---|---|---|---|---|
| Gms. $NH_3$ per Liter. | Gms. Alizarin per Liter. | Gms. NaOH per Liter. | Gms. Alizarin per Liter. | Solid Phase. |
| 0.160 | 0.132 | 0.427 | 1.159 | $C_{14}H_8O_4$ |
| 4.025 | 0.228 | 1.050 | 3.820 | $C_{14}H_8O_4 + C_{14}H_7O_4Na$ |

100 gms. 95% formic acid dissolve 0.10 gm. alizarin at 20.8°. (Aschan, 1913.)

Alizarin is soluble in all proportions in pyridine and in aq. 50% pyridine at 20°–25°. (Dehn, 1917.)

**ALIZARIN** (1.2 Dioxyanthraquinone) $C_{14}H_6O_2(OH)_2$.

100 gms. chloroform dissolve 0.12 gm. alizarin at 20° (Pawlewski, 1914, 1926.)
" carbon tetrachloride " 0.01 " "

**ANTHRACENE** $C_{14}H_{10}$

SOLUBILITY OF ANTHRACENE IN SEVERAL SOLVENTS.

| Solvent. | t° | Gms $C_{14}H_{10}$ per 100 Gms. Solvent. | Authority. |
|---|---|---|---|
| Ethyl Alcohol (abs.) | 16 | 0.076 | (v. Becchi.) |
| " " " | 19.5 | 1.9 | (de Bruyn. 1892.) |
| " " " | 25 | 0.328 | (Hildebrand, Ellefson and Beebe, 1917.) |
| " " " | b. pt. | 0.83 | (v. Becchi.) |
| Methyl Alcohol (abs.) | 19.5 | 1.8 | (de Bruyn 1892.) |
| Benzene | 25 | 1.86 | (Hildebrand, Ellefson and Beebe, 1917.) |
| Carbon Disulphide | 25 | 2.58 | " " " |
| Carbon Tetrachloride | 25 | 0.732 | " " " |
| Ether | 25 | 1.42 | " " " |
| Hexane | 25 | 0.37 | " " " |
| 95% Formic Acid | 18.3 | 0.03 | (Aschan, 1913.) |
| Toluene | 16.5 | 0.92 | (v. Becchi.) |
| " | 100 | 12.94 | " |
| Trichlorethylene | 15 | 1.01 | (Wester and Bruins. 1914.) |

## Solubility of Anthracene in Benzene and in Mixtures of Benzene and Pentane and of Benzene and Heptane.

(Tyrer, 1910, and private communication. See Note, p 735.)

| | In Benzene. | | In Benzene + Pentane at 15°. | | In Benzene + Heptane at 14° and 70°. | | |
|---|---|---|---|---|---|---|---|
| | | | | | | Gms. $C_6H_{10}$ per 100 Gms. Solvent | |
| t°. | d. of Sat. Sol. | Gms. $C_{14}H_{10}$ per 100 Gms. Solvent. | % $C_6H_6$ in Solvent | Gms. $C_{14}H_{10}$ per 100 Gms. Solvent. | % $C_6H_6$ in Solvent. | at 14°. | at 70°. |
| 0 | 0.9008 | 0.605 | 0 | 0.184 | 0 | 0.210 | 1.67 |
| 10 | 0.8909 | 0.975 | 10 | 0.225 | 12.5 | 0.284 | 2.10 |
| 20 | 0.8812 | 1.43 | 20 | 0.279 | 25 | 0.372 | 2.64 |
| 30 | 0.8717 | 2.03 | 30 | 0.357 | 37.5 | 0.474 | 3.23 |
| 40 | 0.8627 | 2.78 | 40 | 0.447 | 50 | 0.592 | 3.87 |
| 50 | 0.8541 | 3.75 | 50 | 0.549 | 62.5 | 0.718 | 4.59 |
| 60 | 0.8460 | 5.14 | 60 | 0.600 | 75 | 0.850 | 5.37 |
| 70 | 0.8374 | 7 | 70 | 0.780 | 87.5 | 0.976 | 6.15 |
| 75 | 0.8347 | 8.35 | 80 | 0.915 | 100 | 1.180 | 6.93 |
| | | | 90 | 1.059 | | | |
| | | | 100 | 1.225 | | | |

Results for the solubility in benzene, differing from the above in some cases by 15%, are given by Findlay (1902).

## Solubility of Anthracene in Alcoholic Picric Acid Solutions at 25°.

(Behrend — Z. physik. Chem. 15, 187, '94.)

| Grams per 100 Grams Solution. | | Solid Phase. | Grams per 100 Gms. Solution. | | Solid Phase. |
|---|---|---|---|---|---|
| Picric Acid. | Anthracene. | | Picric Acid | Anthracene. | |
| 0 | 0.176 | Anthracene | 3.999 | 0.202 | Anthracene Picrate |
| 1.017 | 0.190 | " | 5.087 | 0.180 | " |
| 2.071 | 0.206 | " | 5.843 | 0.162 | " |
| 2.673 | 0.215 | " | 6.727 | 0.151 | " |
| 3.233 | 0.228 | " | 7.511 | 0.149 | Anthracene Picrate + Picric Acid |
| 3.469 | 0.236 | Anthracene and Anthracene Picrate | 7.452 | 0 | Picric Acid |

## Solubility of Anthracene in Various Organic Solvents.

(Clark, 1919*a*.)

The sample of anthracene was 99.8 % pure and melted at 212°.7.

| Solvent. | d of solvent. | B. pt of solvent. | Gms. Anthracene per 100 gms. of solvent at | | | | |
|---|---|---|---|---|---|---|---|
| | | | 15°.5. | 30°. | 50°. | 80°. | 100°. |
| Benzene | 0.880 | 80 – 80.5 | 1.05 | 2.10 | – | – | – |
| Toluene | 0.870 | 110 –110.3 | 0.53 | 1.90 | 3.10 | 7.88 | 12.20 |
| Naphtha (refined) | 0.865 | 145 –166 | 0.46 | 1.42 | 2.90 | 6.58 | 10.10 |
| " (crude solvent) | 0.893 | 152 –179 | 0.50 | 1.71 | 3.25 | 7.20 | 8.82 |
| " (heavy) | 0.909 | 165 –185 | 0.32 | 1.35 | 3.10 | 7.65 | 10.53 |
| Chloroform | 1.495 | 60.4– 62.0 | 0.83 | 1.64 | 7.10 | – | – |
| Carbon disulfide | 1.270 | 45.7– 47.0 | 0.52 | 1.62 | – | – | – |
| Acetone | 0.800 | 56.0– 57.0 | 0.55 | 1.42 | 2.48 | – | – |
| Pyridine (light)* | 0.952 | 125 –150 | 0.85 | 2.15 | 4.10 | 11.22 | 16.72 |
| " (heavy)* | 1.057 | 202 –247 | 0.38 | 1.40 | 2.98 | 7.87 | 8.82 |
| " (hydrated)** | 1.050 | 94 – 96 | 0.0 | 0.0 | 0.001 | 1.53 | – |
| Carbon tetrachloride | 1.610 | 75.5– 76.5 | 0.67 | 1.15 | 1.30 | – | – |
| Gasoline | 0.742 | 90 –164 | 0.12 | 0.37 | 0.76 | – | – |
| Ether | 0.720 | 35 – 40.2 | 0.70 | 1.03 | – | – | – |

* These are the bases derived from coal tar oils by abstraction with sulfuric acid and liberation of the base with caustic soda. They probably contain but very little pyridine, $C_5H_5N$.

** $C_5H_5N.3H_2O$.

### Solubility of Anthracene in Benzene at 30°.5 as Influenced by very Slight Traces of Water in the Benzene.

(Cohen and Miyake, 1926.)

| Thousandths of a wt % of $H_2O$ in the $C_6H_6$. | 0.0 | 38.9 | 88.9 | saturated |
|---|---|---|---|---|
| Gms. anthracene per 100 gms. sat. sol..... | 2.00 | 2.00 | 1.98–1.99 | 1.98 |

100 gms. carbon tetrachloride dissolve 0.47 gms. Anthracene at 20°. } (Pawlewski, 1914, 1926.)
» » chloroform » 1.74 » » » » »

### Solubility of Anthracene in Cymene. (Wheeler, 1920.)

| t°..... | 25°. | 30°. | 100°. | 176°. |
|---|---|---|---|---|
| Gms. anthracene per 100 gms. cymene .... | 1.57 | 1.72 | 9.24 | 98.60 |

### Solubility of Anthracene in Mixtures of Acetone and Ethyl Alcohol.

(Disselkamp, 1926.)

| Wt. per cent acetone in solvent mixture. | Gms. Anthracene per 100 gms. sat. sol. at 50°. | 70°. | 85°. | 100°. |
|---|---|---|---|---|
| 100..... | 2.3 | 3.7 | 6.0 | 10.0 |
| 75..... | 1.6 | 3.2 | 5.5 | 8.1 |
| 50..... | 1.25 | 2.4 | 4.0 | 6.2 |
| 25..... | 0.75 | 1.4 | 2.4 | 4.05 |
| Alcohol..... | 0.4 | 0.7 | 1.4 | 3.45 |

### Solubility of Anthracene in Liquid Sulfur Dioxide in the Critical Region.

(Centnerswer and Teletow, 1903.)

Weighed amounts of anthracene and liquid $SO_2$ were placed in glass tubes which were sealed and rotated at a gradually increasing temperature, and the point observed at which the solid disappeared.

| t°. | Gms $C_{14}H_{10}$ per 100 Gms. $SO_2$. | t°. | Gms. $C_{14}H_{10}$ per 100 Gms. $SO_2$. | t°. | Gms. $C_{14}H_{10}$ per 100 Gms. $SO_2$. |
|---|---|---|---|---|---|
| 40.1 | 2.11 | 65 | 4 | 98 | 9.36 |
| 45.8 | 2.48 | 78.2 | 5.66 | 99.1 | 9.95 |
| 47.9 | 2.65 | 88 | 7.14 | 106.5 | 12.78 |

### Solubility of Anthracene in Mixtures of Solvents.

(Disselkamp, 1926.)

The synthetic method of Alexieff was used. A special shaking apparatus was employed. The individual determinations were plotted and the following results read from the curves.

#### Results for Mixtures of Ethyl Alcohol and Benzene.

| Wt. % $C_6H_6$ in solvent mixture. | Gms. Anthracene per 100 gms. sat. solution at 45°. | 60°. | 75°. | 90°. | 105°. |
|---|---|---|---|---|---|
| 100..... | 3.1 | 4.7 | 7.6 | 12.1 | 16.0 |
| 87.5..... | 2.4 | 4.3 | 6.9 | 10.8 | 14.6 |
| 75.0..... | 1.8 | 2.4 | 5.8 | 9.3 | 8.2 |
| 50.0..... | 1.2 | 2.1 | 3.5 | 5.8 | 8.2 |
| 25.0..... | 0.55 | 1.2 | 1.9 | 3.2 | 4.3 |
| 12.5..... | 0.3 | 0.8 | 1.4 | 2.3 | 3.4 |
| Alcohol..... | 0.23 | 0.55 | 1.05 | 1.68 | 2.5 |

#### Results for Mixtures of Ethyl Alcohol and Carbon Disulfide.

| Wt. % $CS_2$ in solvent mixture. | Gms. Anthracene per 100 gms. sat. solution at 50°. | 55°. | 70°. | 80°. | 90°. |
|---|---|---|---|---|---|
| 100..... | 3.3 | 5.2 | 8.5 | 12.3 | — |
| 80..... | 2.6 | 4.5 | 7.5 | 10.6 | 15.8 |
| 60..... | 1.8 | 3.0 | 4.8 | 6.5 | 8.9 |
| 40..... | 0.85 | 1.55 | 2.75 | 3.9 | 5.4 |
| 20..... | 0.55 | 0.8 | 1.55 | 2.2 | 3.0 |
| Alcohol..... | 0.23 | 0.45 | 0.8 | 1.2 | 1.8 |

$C_{14}H_{10}$

### Results for Mixtures of Acetone and Chloroform.

| Wt. % Acetone in solvent mixture. | Gms. Anthracene per 100 gms. sat. solution at | | | | |
|---|---|---|---|---|---|
| | 45°. | 60°. | 75°. | 90°. | 100°. |
| 100 | 1.6 | 3.0 | 4.6 | 7.1 | 9.7 |
| 75 | 1.4 | 2.6 | 4.2 | 6.7 | 9.2 |
| 50 | 1.2 | 2.5 | 4.1 | 6.5 | 9.1 |
| 25 | 1.5 | 3.9 | 4.6 | 7.3 | 10.2 |
| 10 | 1.95 | 3.6 | 5.5 | 8.5 | 11.9 |
| $CHCl_3$ | 2.5 | 4.5 | 6.4 | 9.6 | 13.0 |

### Results for Mixtures of Acetone and Carbon Disulfide.

| Wt. % Acetone in solvent mixture. | Gms. Anthracene per 100 gms. sat. solution at | | | |
|---|---|---|---|---|
| | 35°. | 50°. | 65°. | 80°. |
| 100 | 1.1 | 2.9 | 4.2 | 5.1 |
| 80 | 2.0 | 3.3 | 5.2 | 8.6 |
| 60 | 2.7 | 4.4 | 7.2 | 11.9 |
| 40 | 3.5 | 5.6 | 8.9 | 14.5 |
| 20 | 4.1 | 6.4 | 10.0 | 15.6 |
| 10 | 3.3 | 5.5 | 8.7 | 13.7 |
| $CS_2$ | 2.7 | 4.5 | 7.4 | 12.3 |

### Results for Mixtures of Carbon Tetrachloride and Carbon Disulfide.

| Wt. % $CCl_4$ in solvent mixture. | Gms. Anthracene per 100 gms. sat. solution at | | | | |
|---|---|---|---|---|---|
| | 35°. | 50°. | 65°. | 80°. | 90°. |
| 100 | 0.44 | 1.0 | 2.13 | 3.4 | 4.6 |
| 80 | 1.15 | 1.9 | 3.2 | 5.1 | 7.1 |
| 60 | 1.7 | 2.7 | 4.3 | 6.7 | 9.6 |
| 40 | 2.15 | 3.4 | 5.4 | 8.4 | 12.2 |
| 20 | 2.45 | 3.9 | 6.5 | 9.9 | 14.7 |
| $CS_2$ | 2.6 | 4.1 | 7.5 | 11.5 | – |

### Results for Mixtures of Carbon Tetrachloride and Toluene.

| Wt. % $CCl_4$ in solvent mixture. | Gms. Anthracene per 100 gms. sat. sol. at | | | | | |
|---|---|---|---|---|---|---|
| | 40°. | 50°. | 65°. | 80°. | 95°. | 100°. |
| 100 | 2.5 | 3.2 | 5.0 | 8.0 | 12.4 | 15.0 |
| 80 | 2.1 | 2.9 | 4.65 | 7.4 | 11.0 | 13.1 |
| 60 | 1.7 | 2.5 | 4.0 | 6.5 | 9.6 | 9.7 |
| 40 | 1.3 | 2.1 | 3.4 | 5.6 | 8.2 | 9.7 |
| 20 | 0.9 | 1.6 | 2.8 | 4.5 | 6.8 | 7.9 |
| Toluene | 0.55 | 1.1 | 2.1 | 3.4 | 5.4 | 6.2 |

### Solubility of Anthracene in Mixtures of :

#### Benzene and Carbon Disulfide.

| Wt. % $C_6H_6$ in solvent mixture. | Gms. Anthracene per 100 gms. sat. sol. at | | | |
|---|---|---|---|---|
| | 40°. | 55°. | 70°. | 85°. |
| 100 | 2.5 | 4.15 | 6.6 | 10.4 |
| 66.7 | 3.0 | 4.8 | 8.1 | 13.4 |
| 50.0 | 3.1 | 5.0 | 8.5 | 14.8 |
| $CS_2$ | 3.2 | 5.2 | 8.7 | 15.1 |

#### Benzene and Chloroform.

| Wt. % $C_6H_6$ in solvent mixture. | Gms. Anthracene per 100 gms. sat. sol. at | | | |
|---|---|---|---|---|
| | 50°. | 70°. | 85°. | 100°. |
| 100 | 3.55 | 6.5 | 10.3 | 16.1 |
| 80 | 3.3 | 6.0 | 9.0 | 13.1 |
| 50 | 3.1 | 5.8 | 8.6 | 12.3 |
| $CHCl_3$ | 3.0 | 5.6 | 8.3 | 11.8 |

### Solubility of Anthracene in Mixtures of :

#### Toluene and Carbon Disulfide.

| Wt. % $C_6H_5CH_3$ in solvent. | Gms. Anthracene per 100 gms. sat. sol. at | | | |
|---|---|---|---|---|
| | 40°. | 55°. | 70°. | 85°. |
| 100 | 2.1 | 3.8 | 6.0 | 9.4 |
| 75 | 2.55 | 4.4 | 7.0 | 11.6 |
| 50 | 2.8 | 4.75 | 7.6 | 13.0 |
| $CS_2$ | 3.1 | 5.0 | 8.3 | 14.5 |

#### Toluene and Chloroform.

| Wt. % $C_6H_5CH_3$ in solvent. | Gms. Anthracene per 100 gms. sat. sol. at | | |
|---|---|---|---|
| | 40°. | 60°. | 85°. |
| 100 | 1.95 | 4.5 | 8.0 |
| 71.4 | 2.1 | 4.1 | 7.7 |
| 50.0 | 2.2 | 3.95 | 7.6 |
| 25.0 | 2.2 | 4.0 | 7.7 |
| $CHCl_3$ | 2.1 | 4.4 | 7.85 |

### Results for Mixtures of Benzene and Toluene.

| Wt. % $C_6H_5CH_3$ in solvent mixture. | Gms. Anthracene per 100 gms. sat. sol. at 40°. | 60°. | 75°. | 90°. |
|---|---|---|---|---|
| 100 | 2.45 | 4.45 | 6.7 | 10.6 |
| 50 | 2.6 | 4.7 | 8.2 | 11.4 |
| $C_6H_6$ | 2.75 | 5.1 | 8.7 | 12.4 |

### Solubility of Anthracene at 17°.95 in Mixtures of :
(Joscht, 1914, 1926.)

Benzene and Ethyl Acetate.

| Gms. $C_6H_6$ per 100 gms. solvent. | Gms. $C_{14}H_{10}$ per 100 gms. solvent. | Gms. $C_6H_6$ per 100 gms. solvent. | Gms. $C_{14}H_{10}$ per 100 gms. solvent. |
|---|---|---|---|
| 0.0 | 0.120 | 50.0 | 0.180 |
| 10.0 | 0.139 | 60.0 | 0.199 |
| 20.0 | 0.137 | 70.0 | 0.210 |
| 30.0 | 0.163 | 80.0 | 0.204 |
| 40.0 | 0.177 | 90.0 | 0.226 |
| 49.3 | 0.164 | 100.0 | 0.223 |

Acetone and Carbon Tetrachloride.

| Gms. $CCl_4$ per 100 gms. solvent. | Gms. $C_{14}H_{10}$ per 100 gms. solvent. | Gms. $CCl_4$ per 100 gms. solvent. | Gms. $C_{14}H_{10}$ per 100 gms. solvent. |
|---|---|---|---|
| 100.0 | 0.470 | 40.0 | 0.971 |
| 90 | 0.740 | 30.0 | 0.967 |
| 80 | 0.873 | 20.0 | 0.966 |
| 70 | 0.936 | 10.0 | 0.962 |
| 60 | 0.962 | 0.0 | 0.938 |
| 50 | 0.985 | | |

### Solubility of Anthracene at 25° in Mixtures of;
(Mahieu 1936.)

Bromobenzene + Chlorobenzene

| Gms. $C_6H_5Cl$ per 100 gms. $C_6H_5Cl+C_6H_5Br$ | Gms. $C_{14}H_{10}$ per 100 gms. solvent |
|---|---|
| 0.0 | 1.37 |
| 24.5 | 1.43 |
| 50.5 | 1.51 |
| 75.5 | 1.56 |
| 100 | 1.64 |

Ether + Benzene

| Gms. $C_6H_6$ per 100 gms. $C_6H_6+(C_2H_5)_2O$ | Gms. $C_{14}H_{10}$ per 100 gms. solvent |
|---|---|
| 0.0 | 0.85 |
| 29.8 | 1.0 |
| 50.0 | 1.28 |
| 70.6 | 1.45 |
| 100.0 | 1.70 |

Ether + Chloroform

| Gms. $(C_2H_5)_2O$ per 100 gms. $(C_2H_5)_2O+CHCl_3$ | Gms. $C_{14}H_{10}$ per 100 gms. solvent |
|---|---|
| 0.0 | 1.62 |
| 26.2 | 0.794 |
| 58.6 | 0.610 |
| 70.0 | 0.614 |
| 100 | 0.851 |

## ANTHRACENE

### Solubility of Anthracene at 25° in Mixtures of Nitrobenzene and:
(Mahieu, 1936.)

Aniline

| Gms. $C_6H_5NH_2$ per 100 gms. $C_6H_5NH_2 + C_6H_5NO_2$ | Gms. $C_{14}H_{10}$ per 100 gms. solvent |
|---|---|
| 0.0 | 1.51 |
| 22.2 | 3.64 |
| 48.9 | 1.64 |
| 67.2 | 1.30 |
| 100.0 | 0.75 |

Acetone

| Gms. $(CH_3)_2CO$ per 100 gms. $(CH_3)_2CO + C_6H_5NO_2$ | Gms. $C_{14}H_{10}$ per 100 gms. solvent |
|---|---|
| 0.0 | 1.51 |
| 24.9 | 1.71 |
| 47.5 | 1.55 |
| 74.5 | 1.36 |
| 100 | 1.33 |

Carbon Disulfide

| Gms. $C_6H_5NO_2$ per 100 gms. $C_6H_5NO_2 + CS_2$ | Gms. $C_{14}H_{10}$ per 100 gms. solvent |
|---|---|
| 0.0 | 2.03 |
| 24.1 | 3.36 |
| 49.1 | 2.54 |
| 72.6 | 1.90 |
| 100 | 1.51 |

Hexane

| Gms. $C_6H_{14}$ per 100 gms. $C_6H_{14} + C_6H_5NO_2$ | Gms. $C_{14}H_{10}$ per 100 gms. solvent |
|---|---|
| 9.8 | 1.67 |
| 28.7 | 1.64 |
| 45.3 | 1.32 |
| 73.1 | 0.75 |
| 100.0 | 0.31 |

## Solubility of Anthracene in Mixtures of:

(Mahieu, 1936.)

Methyl Alcohol and Benzene at 25°

| Gms. $C_6H_6$ per 100 gms. $C_6H_6$ + $CH_3OH$ | Gms. $C_{14}H_{10}$ per 100 gms. solvent |
|---|---|
| 0.0 | 0.14 |
| 25.6 | 0.34 |
| 51.5 | 0.68 |
| 74.0 | 1.25 |
| 88.0 | 1.53 |

Methyl Alcohol and $CS_2$ at 40°

| Gms. $CH_3OH$ per 100 gms. $CH_3OH$ + $CS_2$ | Gms. $C_{14}H_{10}$ per 100 gms. solvent |
|---|---|
| 0.0 | 3.14 |
| 25.9 | 1.51 |
| 45.3 | 0.753 |
| 75.7 | 0.462 |
| 100.0 | 0.168 |

Propyl Alcohol and Benzene at 25°

| Gms. $C_6H_6$ per 100 gms. $C_6H_6$ + $C_3H_7OH$ | Gms. $C_{14}H_{10}$ per 100 gms. solvent |
|---|---|
| 0.0 | 0.11 |
| 27.9 | 0.39 |
| 50.9 | 0.76 |
| 74.0 | 1.13 |
| 100.0 | 1.70 |

Aniline and Cyclohexane at 40°

| Gms. $C_6H_5NH_2$ per 100 gms. $C_6H_5NH_2$ + $C_6H_{14}$ | Gms. $C_{14}H_{10}$ per 100 gms. solvent |
|---|---|
| 0.0 | 0.65 |
| 20.3 | 1.0 |
| 51.7 | 1.9 |
| 75.2 | 1.77 |
| 100.0 | 1.49 |

Freezing-point data are given for mixtures of Anthracene and:

Acridine(16)
Amino phenols(1)
Camphor(5)
Carbazole(17)
" + Chrysene(17)
" + Phenanthrene(3)(12)(15)(16)(22)
Chrysene(17)
Dihydro anthracene(4)
Dinitro benzenes(11)
" phenols(11)
" toluenes(10)(11)
Diphenyl(20)
Diphenyl amine(20)
Methyl acridine(17)
Naphthols(20)
Naphthylamines(20)
Naphthalene(21)
Nitrobenzene + Quinone(13)
Nitro phenols(11)
Phenanthrene(2)(3)(17)(20)
" + Carbazole(3)(12)(15)(16)(22)
Phenylene diamine(1)
Picric acid(9)(18)
Picrimide(6)
Picryl chloride(6)
Quinone(13)
Quinone + Nitrobenzene(13)
Retene(17)
Resorcinol(20)
Styphnic acid(7)
Tetra nitro benzene(19)
Toluidine(20)
Trinitro benzene(11)
" cresol(8)
" phenol(14)
" toluene(7)(11)
Tri phenyl methane(20)

(1) Bernoulli and Lotter, 1933; (2) Bradley and Marsh, 1933; (3) Garelli, 1894; (4) Grimm, Gunther and Titus, 1931; (5) Jefremow, 1913a, 1914, 1916; (6) Jefremow, 1918; (7) Jefremow, 1919, 1919a; (8) Jefremow and Tichomirowa, 1927; (9) Kremann, 1905; (10) Kremann, Hönigsberg and Mauermann, 1923; (11) Kremann and Müller II, 1921; (12) Kremann and Wenzig, 1917; (13) Kremann, Sutter, Sitte, Strzelba and Dobotsky, 1922; (14) Milone and Rossignolli, 1932; (15) Mortimer, 1928; (16) Pascal, 1914; (17) Pascal, 1921; (18) Rheinboldt, Henning and Kirscheisen, 1925; (19) Shinomiya, 1940; (20) Vignon, 1891; (21) Vignon and Miolati, 1892; (22) Ward, 1926.

## PHENANTHRENE $C_{14}H_{10}$.

### Solubility of Phenanthrene in Aqueous Solutions of Alcohols at 20°.

(Gregg-Wilson and Wright, 1928.)

Results for aqueous solutions of:

| Methyl Alcohol | | Ethyl Alcohol | | Propyl Alcohol | |
|---|---|---|---|---|---|
| Wt. % $CH_3OH$ in Aq. solvent | Gms. $C_{14}H_{10}$ per 100 gms. solvent | Wt. % $C_2H_5OH$ in Aq. solvent | Gms. $C_{14}H_{10}$ per 100 gms. solvent | Wt. % $C_3H_7OH$ in Aq. solvent | Gms. $C_{14}H_{10}$ per 100 gms. solvent |
| 59.8 | 0.12 | 61.4 | 0.28 | 69.8 | 1.05 |
| 79.0 | 0.62 | 80.0 | 1.27 | 79.0 | 1.50 |
| 88.7 | 1.27 | 90.4 | 2.17 | 93.5 | 2.67 |
| 96.0 | 2.27 | 95.6 | 2.91 | 95.4 | 2.93 |
| 100.0 | 3.18 | 100.0 | 4.15 | 100 | 3.51 |

Behrend, 1892, reports 2.77 gms. phenanthrene per 100 gms. alcohol at 12.3°, and 3.09 gms. at 14.8°.

### Solubility of Phenanthrene in Organic Acids. (Timofeiew, 1894.)

| Acid. | t°. | Gms. $C_{14}H_{10}$ per 100 Gms. Sat. Sol. | Acid. | t°. | Gms. $C_{14}H_{10}$ per 100 Gms. Sat. Sol. |
|---|---|---|---|---|---|
| Acetic Acid | 23 | 8.31 | Propionic Acid | 23 | 17 |
| " " | 39 | 9.8 | " " | 39 | 21.4 |
| " " | 70.5 | 34.6 | " " | 62.4 | 40.3 |
| Butyric Acid | 23 | 15.6 | Isobutyric Acid | 23 | 12.3 |
| " " | 39 | 21 | Valeric Acid | 39 | 16.6 |

100 gms. 95% formic acid dissolve 0.46 gms. $C_{14}H_{10}$ at 20.8° (Aschan, 1913.)

## PHENANTHRENE $C_{14}H_{10}$.

### Solubility of Phenanthrene in Alcohol and in Toluene.

(Speyers, 1902.)

In Alcohol

| t°. | Sp. gr. of sat. sol. | Gms. $C_{14}H_{10}$ per 100 gms. $C_2H_5OH$. |
|---|---|---|
| 0..... | 0.814 | 2.2 |
| 10..... | 0.807 | 3.5 |
| 20..... | 0.801 | 4.5 |
| 25..... | 0.799 | 5.1 |
| 30..... | 0.797 | 5.8 |
| 40..... | 0.795 | 7.3 |
| 50..... | 0.794 | 9.5 |
| 60..... | 0.797 | 14.0 |
| 70..... | 0.815 | 30.0 |

In Toluene.

| t° | Sp. gr. of sat. sol. | Gms. $C_{14}H_{10}$ per 100 gms. $C_6H_5CH_3$. |
|---|---|---|
| 0..... | 0.925 | 26.0 |
| 10..... | 0.929 | 30.0 |
| 20..... | 0.934 | 45.0 |
| 25..... | 0.939 | 55.0 |
| 30..... | 0.943 | 70.0 |
| 40..... | 0.955 | 140.0 |
| 50..... | 0.971 | 172.0 |
| 60..... | 0.989 | 280.0 |
| 70..... | 1.007 | 480.0 |
| 78..... | 1.020 | 850.0 |

SOLUBILITY OF PHENANTHRENE IN SEVERAL ORGANIC SOLVENTS. (Hedstock, 1922.)

The solutions were saturated by constant agitation and analyzed by evaporating and weighing the dried residue.

| Solvent. | Gms. $C_{14}H_{10}$ per 100 gms. solvent at −10°. | −5°. | 0°. | +5°. | 10°. | 15°. | 20°. | 25°. | 30°. |
|---|---|---|---|---|---|---|---|---|---|
| (1)..... | 0.0 | 0.60 | 1.20 | 1.80 | 2.40 | 3.00 | 3.60 | 4.20 | 4.80 |
| (2)..... | 0.8 | 1.60 | 2.40 | 3.20 | 4.00 | 5.00 | 6.60 | 8.40 | 10.60 |
| (3)..... | 1.75 | 2.25 | 2.75 | 3.26 | 3.77 | 4.28 | 4.80 | 5.50 | 5.81 |
| (4)..... | | | – | | – | 5.00 | 5.80 | 6.60 | 7.80 |
| (5)..... | 5.50 | 6.10 | 7.60 | 9.80 | 12.66 | 15.80 | 19.00 | 22.50 | 26.20 |
| (6)..... | 12.20 | 14.80 | 17.44 | 20.64 | 23.84 | 30 64 | 36.78 | 43.22 | 50.42 |
| (7)..... | 15.70 | 20.00 | 25.50 | 31.02 | 36.54 | 42.50 | 51.94 | 63.50 | 77.46 |
| (8)..... | 21.20 | 22.70 | 25.50 | 29.60 | 34.30 | 39.90 | 46.60 | 54.60 | 64.20 |
| (9)..... | | | – | 29.86 | 36.66 | 44.06 | 51.70 | 60.32 | 69.68 |
| (10)..... | 21.60 | 28.84 | 37.30 | 45.88 | 54.48 | 63.28 | 72.08 | 80.92 | 89.82 |

(1) Methyl alcohol; (2) Light petroleum (b. pt. 60°-85°); (3) Ethyl alcohol; (4) Glacial acetic acid; (5) Carbon tetrachloride; (6) Ethyl ether; (7) Acetone; (8) Chloroform; (9) Benzene; (10) Carbon disulfide.

Additional determinations in solvent (5) carbon tetrachloride, gave results higher than the above, but it is probable that equilibrium had not been reached.

* 9.20 gms. at 35° and 11.20 gms. at 40°.

SOLUBILITY OF PHENANTHRENE IN SEVERAL ORGANIC SOLVENTS.
(Clark, 1919 *a*.)

| Solvent. | *d* of solvent | B. pt. of solvent. | Gms. $C_{14}H_{10}$ per 100 gms. solvent at 15°.5. | 30°. | 50°. | 80°. |
|---|---|---|---|---|---|---|
| Benzene..... | 0.880 | 80° 80°.5 | 16.72 | 40.10 | – | – |
| Toluene..... | 0.870 | 110 110.3 | 13.80 | 29.10 | – | – |
| Refined solvent Naphtha.. | 0.865 | 145 -166 | 12.52 | 22.42 | 30.8 | 84.8 |
| Crude » » .. | 0.893 | 152 -179 | 15.30 | 31.80 | 74.2 | 243.0 |
| Heavy Naphtha..... | 0.909 | 165 185 | 11.94 | 21.30 | 60.3 | 193.0 |
| Chloroform ..... | 1.495 | 60.4 62.0 | 18.70 | 29.20 | – | – |
| Carbon disulfide..... | 1.270 | 45.7 47.0 | 26.42 | – | – | – |
| Acetone..... | 0.800 | 56.0 57.0 | 15.08 | 22.40 | – | – |
| Light Pyridine (1)..... | 0.952 | 125 150 | 25.54 | 38.0 | 78.9 | 241.0 |
| Heavy » (1)..... | 1.056 | 202 -247 | 20.00 | 24.5 | 64.7 | 182.0 |
| Hydrated Pyridine..... | 1.050 | 94 - 96 | 0.43 | 1.32 | 7.4 | 11.1 |
| Carbon Tetrachloride..... | 1.610 | 75.5 76.5 | 7.40 | 11.24 | – | – |
| Gasoline..... | 0.740 | 90 164 | 4.53 | 6.30 | – | – |
| Ethyl Ether..... | 0.720 | 35 40.2 | 8.93 | 15.24 | – | – |

(1) These are the bases derived from coaltar oils by abstraction with sulfuric acid and liberation of the base with caustic soda. They probaby contain but very little pyridine, $C_5H_5N$.

100 gms. methyl formate dissolve 26.1 gms. $C_{14}H_{10}$ at 25°. (Kröber, 1919.)

100 gms. sat. solution of Phenanthrene in liquid Sulfur Dioxide contain 23 gms. $C_{14}H_{10}$ at ? t°. (DeCarli, 1927.)

SOLUBILITY OF PHENANTHRENE IN SEVERAL SOLVENTS AT 25°.
(Hildebrand, Ellefson and Beebe, 1917.)

| Solvent. | Gms. $C_{14}H_{10}$ per 100 Gms. Solvent. | Solvent. | Gms. $C_{14}H_{10}$ per 100 Gms. Solvent. |
|---|---|---|---|
| Alcohol | 4.91 | Carbon Tetrachloride | 26.3 |
| Benzene | 59.5 | Ether | 42.9 |
| Carbon Disulfide | 80.3 | Hexane | 9.15 |

### Solubility of Phenanthrene Picrate in Absolute Alcohol.
(Behrend, 1892.)

| t°. | Grams per 100 Grams Saturated Solution. | | |
|---|---|---|---|
| | Picric Acid + | Phenanthrene = | Phenanthrene Picrate. |
| 12.3 | 0.91 | 0.71 | 1.62 |
| 14.3 | 1.00 | 0.78 | 1.78 |
| 17.5 | 1.05 | 0.82 | 1.87 |

### Solubility of Phenanthrene Picrate in Alcoholic Solutions Containing Picric Acid and also Phenanthrene.
(Behrend.)

| t°. | Grams Added to 62 cc. Abs. Alcohol. | | | Gms. per 100 Gms. Sat. Solution. | | |
|---|---|---|---|---|---|---|
| | P. Picrate + | Picric Ac. + | Phenanthrene. | Picric Ac. + | Phenanthrene = | P. Picrate. |
| 12.3 | 1.4 | 0 | 0.5 | 0.534 | 1.413 | 1.947 |
| 12.3 | 1.4 | 0 | 0.9 | 0.409 | 2.141 | 2.550 |
| 12.3 | 0.8 | 0 | 2.1 | 0.354 | 2.77 | 3.124 |
| 12.3 | 0.8 | 0 | 4.0 | 0.139 | 5.626 | 5.765 |
| 17.5 | 1.4 | 0.1 | 0 | 1.159 | 0.75 | 1.91 |
| 17.5 | 1.4 | 0.2 | 0 | 1.285 | 0.68 | 1.97 |
| 17.5 | 1.4 | 1.0 | 0 | 2.45 | 0.37 | 2.82 |
| 17.5 | 1.4 | 4.0 | 0 | 6.15 | 0.195 | 6.345 |
| 17.5 | 1.4 | 0.0 | 2.2 | 0.423 | 3.276 | 3.699 |

Freezing-point data are given for mixtures of Phenanthrene and:

Acridine(15)
Amino phenols(2)
Anthracene(3)(5)(15)(17)
" + Carbazole(5)(6)(15)(18)
Benzene(4)
" + Carbazole(4)
Carbazole(5)
" + benzene(4)
" + anthracene(5)(6)(15)(18)
Chrysen(15)
Dinitro benzene(9)
" toluenes(9)(10)
Diphenyl(17)
" amine(14)
Hydroquinone(1)
Naphthalene(12)(13)(17)
Phenanthrene(19)
Phenylene diamines(2)
Picramide(7)
Picric acid(7)
Picryl chloride(7)
Pyrocatechol(1)
Quinone(11)
Resorcinol(1)
Retene(15)
Styphnic acid(7)
Tetranitro benzene(16)
Tetryl(8)
Trinitro benzene(9)
" cresol(8).
" toluenes(9)

(1) Bernoulli and Sarasin, 1930; (2) Bernoulli and Lotter, 1933; (3) Bradley and Marsh, 1933; (4) Bruni, 1898; (5) Garelli, 1895; (6) Hrynakowski and Kapuscinski, 1934; (7) Jefremow, 1918, 1919a; (8) Jefremow and Tichomirowa, 1927, 1928; (9) Kremann et al, 1908; (10) Kremann and Hofmeier, 1910; (11) Kremann, Sutter, Sitte Strzelba and Dobotzky, 1922; (12) Milone and Rossignolli, 1932; (13) Miolati, 1897; (14) Narbutt, 1905; (15) Pascal, 1921; (16) Shinomiya, 1940; (17) Vignon, 1891; (18) Ward, 1926; (19) Kurnakov and Jefremow, 1912.

**TOLAN** (Acetylene diphenyl) $C_6H_5CC{:}C_6H_5$.

Freezing-point data for mixtures of tolan with dibenzyl, with benzal aniline and with azobenzene are given by Pascal and Normand, 1913.

**AZOXY BENZENE** $C_6H_5(NON)C_6H_5$.

Freezing-point data for mixtures of azoxy benzene and azobenzene are given by Hartley and Stewart, 1914.

**BENZIL** $C_6H_5CO.COC_6H_5$.

Data for the solubility of benzil in aqueous ethyl alcohol are given by Timmermans (1907) and by Kendall and Gibbons (1915). Data for aqueous solutions of benzil and phenol, for benzil and succinic acid nitrile and for benzil and triethyl amine are given by Timmermans (1907).

Freezing-points are given for mixtures of Benzil and:

| | | |
|---|---|---|
| Acenaphthene(6) | Benzoin(2)(8) | Hydrobenzoin(9) |
| Azobenzene(7)(9) | Chlor acetic acid(4) | Naphthalene(1) |
| Benzanilide(9) | Dibenzyl(9) | Stilbene(9) |
| Benzoic acid(4)(5) | Dibenzoyl ethylene(3) | Trichlor acetic acid(4) |

(1) Bernoulli and Sarasin, 1913; (2) Beurath, 1912-13; (3) Grimm, Gunther and Titus, 1931; (4) Kendall and Gibbons, 1915; (5) Passerini, 1924; (6) Pawlewski, 1893; (7) Tammann and Botschwar, 1926; (8) Vanstone, 1909; (9) Vanstone, 1913.

Phthalyl **PHENYL HYDRAZIDE** $C_6H_4\langle^{CO}_{CO}\rangle N.N\langle^{H}_{C_6H_5}$.

Phthalyl **PHENYL** Methyl **HYDRAZIDE** $C_6H_4\langle^{CO}_{CO}\rangle N.N\langle^{CH_3}_{C_6H_5}$.

Very careful determinations of the solubilities of the enantrotropic forms of these two compounds in alcohol, chloroform, ethyl acetate, acetone, benzene and in methyl alcohol are given by Chattaway and Lambert (1915).

SOLUBILITY OF THE TAUTOMERIC FORMS OF HYDRAZIDES IN BENZENE AT 5°

Determined by the freezing-point method. (Sidgwick, 1915.)

| Compound. | Formula. | | Gms. Compound Dissolved per Liter Benzene. |
|---|---|---|---|
| Phthalylphenylhydrazide | $C_6H_4\langle^{CO}_{CO}\rangle N.NH.C_6H_5$ | *A* form | 5.5 |
| | | *C* form | 1.1 |
| Phthalylphenylmethylhydrazide | $C_6H_4\langle^{CO}_{CO}\rangle N.N(CH_3)C_6H_5$, *A* form | | 124 |

Diphenylene **GLYCOLIC ACID** (ms-Oxyfluorene carbonic acid) $(C_6H_4)_2C(OH).COOH$.

SOLUBILITY IN AQUEOUS SOLUTIONS OF HYDROCHLORIC ACID AT 25°.

(Knox and Richards, 1919.)

| Equivalent Normality. | | Equivalent Normality | |
|---|---|---|---|
| HCl. | $C_{14}H_{10}O_3$. | HCl. | $C_{14}H_{10}O_3$. |
| 0.00 | 0.01082 | 5.843 | 0.00343 |
| 1.952 | 0.00492 | 7.745 | 0.00352 |
| 3.907 | 0.00355 | | |

**DIPHENIC ACID** (o, o' bibenzoic acid) $HOOC(o)C_6H_4.C_6H_4(o)COOH$.

SOLUBILITY OF DIPHENIC ACID IN AQUEOUS SOLUTIONS OF HYDROCHLORIC ACID AT 25°. (Knox and Richards, 1919.)

| | | | | | |
|---|---|---|---|---|---|
| Equiv. Normality of HCl..... | 0.00 | 2.103 | 3.985 | 5.928 | 7.548 |
| " $C_{14}H_{10}O_4$. | 0.00590 | 0.00182 | 0.00141 | 0.00112 | 0.00118 |

**BENZOYL PEROXIDE** $(C_6H_5CO)_2O_2$.

Freezing-point data for mixtures of benzoyl peroxide and di benzoyl ethane are given by Grimm, Gunther and Titus, 1931.

**BENZOIC ANHYDRIDE** $(C_6H_5CO)_2O$.

Freezing-point data for mixtures of benzoic anhydride with acetamide and with benzamide are given by Kremann, Mauermann and Oswald, 1922.

**r-2:4-DINITRO-2'-METHYL DIPHENYL-6-CARBOXYLIC ACID.** $(NO_2)_2COOHC_6H_2.C_6H_4CH_3$.

SOLUBILITY OF THE r-ACID IN BENZENE.
(Hammick and Williams, 1935.)

Weighed quantities of the r-Acid and benzene were sealed in tubes and the temperatures determined at which the last trace of solid remained in equilibrium with the liquid.

| $t^0$ | Mol. % of r-Acid | Solid Phase | $t^0$ | Mol. % of r-Acid | Solid Phase |
|---|---|---|---|---|---|
| 5.5 | 0.0 | $C_6H_6$ | 134.6 | 59.9 | $2C_{14}H_{10}O_6N_2.C_6H_6$ |
| 115.3 | 22.9 | $C_{14}H_{10}O_6N_2.C_6H_6$ | 136.2 | 63.2 | " |
| 128.5 | 41.0 | " | 137.1 | 64.3 | " |
| 129.6 | 51.0 | " | 138.3 | 67.9 | $C_{14}H_{10}O_6N_2$ |
| 128(1) | 55.0 | " $+2C_{14}H_{10}O_6.N_2.C_6H_6$ | 140.6 | 72.0 | " |
| 132.6(1) | 58.2 | $2C_{14}H_{10}O_6N_2.C_6H_6$ | 147.8 | 83.7 | " |
| | | | 155.5 | 100.0 | " |

(1) Estimated from author's diagram.

**TANNIC ACID**

When a sample of tannic acid of apparently very good quality was added to water at room temperature, the solution increased so greatly in viscosity, that even before the saturation point was reached, it became evident that a satisfactory separation of liquid and solid could not be made. The solubility in water is variously given in the pharmaceutical literature from about 20 to 300 gms. tannic acid per 100 gms. of water. Similarly, the quoted results for the solubility in alcohol vary from about 50 to 400 gms. acid per 100 gms. of alcohol. (Seidell, 1910.)
100 gms. glycerol dissolve 48.8 gms. tannin at 15–16°. (Ossendowski, 1907.)
100 gms. trichlorethylene dissolve 0.012 gm. tannin at 15°. (Wester and Bruins, 1914.)

**3-METHYL ACRIDINE** $C_{13}H_8N.CH_3$.

Freezing-point data are given for:

3-Methyl acridine + Acridine (Pascal, 1914.)
" " + Anthracene (Pascal, 1921.)

**DESYL CHLORIDE** $C_6H_5CHClCOC_6H_5$.

Freezing-point data for mixtures of desyl chloride and methyl desoxybenzoin are given by Preiswerk and Erlenmeyer, 1934.

**BENZIL α and β MONO-OXIME** $C_6H_5COC(:NOH)-C_6H_5$.

Results for equilibrium in the systems Benzil α and β mono-oximes and benzene are given by Taylor and Marks, 1930.

**STILBENE** $C_6H_5CH:CH.C_6H_5$.

Freezing-point data for mixtures of stilbene and *p* dimethoxystilbene are given by Pascal and Normand (1913).

Freezing-point data are given for mixtures of:

Stilbene + Azobenzene (Pascal and Normand, 1913; Beck, 1904.)
" + Benzil (Vanstone, 1913.)
" + Benzal aniline (Pascal and Normand, 1913.)
" + Bibenzyl " " " "; Bruni, 1898; Garelli, and Colzolari, 1899.)
" + Picric acid (Jefremow, 1918.)
" + Styphnic acid (Jefremow, 1918, 1919a.)
" + Azo toluene (Pascal and Normand, 1913.)

**DIHYDRO ANTHRACENE** $9,10\text{-}C_6H_4:(CH_2)_2:C_6H_4$.

Freezing-point data for mixtures of dihydro anthracene and anthracene are given by Grimm, Gunther and Titus, 1931.

**BENZALAZINE** (Benzaldehyde azine) $C_6H_5CH:NN:CHC_6H_5$.

Freezing-point data are given by Pascal, 1914, 1921, for mixtures of benzalazine and each of the following compounds: Cinnamylidene aniline, dibenzyl hydrazine, dimethyl hydrazine, diphenyl butadien, diphenyl diacetylene, diphenyl hydrazine, furfuralizine, naphthalene and α naphtholazine. Results are also given for mixtures of Thio phenyl alazine and cinnamylidene.

**ACETYL BIPHENYL** (Biphenyl methyl ketone) $C_6H_5C_6H_4COCH_3$.

Freezing-point data are given for mixtures of acetyl biphenyl with β naphthylamine and with p toluylic acid by Pfeiffer, Angern, Wang, Seydel and Quehl, 1930.

Phenyl Glyoxal**PHENYL HYDRAZONE**, α and β forms, $C_6H_5.CO.CH:N.NHC_6H_5$

Solubility of Phenyl Glyoxal Hydrazone in Several Solvents.
(Sidgwick and Ewbank, 1921.)

The determinations were made by the synthetic method. In the case of alcohol as the solvent, the α form of the compound is transformed into the β form before saturation is reached. Hence results could be obtained only for the β form in alcohol. M. pt. of α form = 114-117°; of β form = about 145-146°.

Results of the Solubility Determinations in :

Ethyl Alcohol.

| t°. | Gms. β form of the cmpd. per 100 gms. sat. sol. |
|---|---|
| 70..... | 8.8 |
| 83.4.... | 19.6 |
| 93.5.... | 39.5 |
| 98.0.... | 55.9 |
| 103.4.... | 74.9 |
| 113.5.... | 90.2 |
| 128.5.... | 100.0 |

Benzene.

| t°. | Gms. β form of the cmpd. per 100 gms. sat. sol. |
|---|---|
| 3.0.... | 0.322 |
| 26..... | 4.8 |
| 44.2.... | 10.4 |
| 59.1.... | 19.9 |
| 67.9.... | 30.2 |
| 74.3.... | 38.6 |
| 79.5.... | 45.0 |
| 98.0.... | 70.8 |
| 115.1.... | 89.8 |

| t°. | Gms. α form of the cmpd. per 100 gms. sat. sol. |
|---|---|
| 3.0.... | 5.84 |
| 8.0.... | 10.4 |
| 29.0.... | 19.9 |
| 40.8.... | 30.2 |
| 50.0.... | 38.6 |
| 56.0.... | 45.0 |
| 75.3.... | 89.8 |

In Normal Heptane :

| t°. | Gms. compd. per 100 gms. sat. sol. | Solid Phase. | t°. | Gms. cmpd. per 100 gms. sat. sol. | Solid Phase. |
|---|---|---|---|---|---|
| 71.72..... | 1.82 | β form | 58.2..... | 4.63 | α form |
| 80.81..... | 4.63 | » | 75.8..... | 10.1 | » |
| 93.5..... | 10.1 | » | 84.7..... | 17.0 | » |
| 103.2..... | 17.0 | » | 94.0..... | 35.4 | » |
| 111.0..... | 35.4 | » | 96.0..... | 55.9 | » |
| 113.0..... | 55.9 | » | | | » |

Solubility of the two Forms, Each Determined Separately in Several Solvents at 32°.

| Solvent. | Gms. per 100 gms. sat. sol. α form. | Gms. per 100 gms. sat. sol. β form. | Ratio. |
|---|---|---|---|
| Benzene..... | 25.1 | 8.0 | 3.1 to 1.0 |
| Heptane..... | 1.7 | 0.55 | 3.1 to 1.0 |
| Carbon tetrachloride..... | 8.8 | 2.27 | 3.9 to 1.0 |
| Cyclo Hexane..... | 2.56 | 1.56 | 1.7 to 1.0 |

**BENZOIN** (Benzoyl phenyl carbinol) $C_6H_5CH(OH)COC_6H_5$.

Solubility of Benzoin in Water, Pyridine and Aqueous 50% Pyridine at 20–25°.

(Dehn, 1917.)

| Solvent. | Gms. Benzoin per 100 gms. Solvent. |
|---|---|
| Water | 0 03 |
| Aq. 50 % Pyridine | 6.63 |
| Pyridine | 20.20 |

100 gms. 95% formic acid dissolve 3.06 gms. benzoin at 18.5°. (Aschan, 1913.)

**BENZOIN**, Hydro **BENZOIN** and Desoxy **BENZOIN**.

Solubility of Each in Chloroform and in Carbon Tetrachloride at 20°.

(Pawlewski, 1914, 1926.)

| Compound. | Formula. | Gms. cmpd. dissolved per 100 gms. $CHCl_3$. | Gms. cmpd. dissolved per 100 gms. $CCl_4$. |
|---|---|---|---|
| Benzoin..... | $C_6H_5CH(OH)CO.C_6H_5$ | 4.01 | 0.20 |
| Hydrobenzoin..... | $(C_6H_5.CHOH)_2$ | 1.60 | 0.105 |
| Desoxybenzoin..... | $C_6H_5CH_2COC_6H_5$ | 28.96 | 12.13 |

Freezing-point data are given for mixtures of Benzoin and:

Azobenzene(7)
Benzanilide(7)
Benzil(2)(6)
Benzylaniline(7)
Benzylidene aniline(7)
Bibenzyl(7)
Hydrazo benzene(7)
Hydro benzoin(3)
Methyl desoxy benzoin(5)
Naphthalene(1)
Resorcinol(4)

Results for mixtures of Hydrobenzoin and benzil(7)

(1) Bernoulli and Sarasin, 1930; (2) Beurath, 1912-13; (3) Carre and Mauclere, 1931; (4) Dischendorfer, 1933; (5) Preiswerk and Erlenmeyer, 1934; (6) Vanstone, 1909; (7) Vanstone, 1913.

**PHENYL ANISYL KETONE** $C_6H_5COCH_3OC_6H_4$.

Freezing-point data for mixtures of phenyl anisyl ketone and tri chlor acetic acid are given by Kendall and Gibbons, 1915.

## BENZILIC ACID $(C_6H_5)_2.C(OH).COOH.$

### Solubility of Benzilic Acid in Aqueous Solutions of Hydrochloric Acid at 25°. (Knox and Richards, 1919.)

| Gm. equivalents per liter | |
|---|---|
| HCl. | $C_{14}H_{12}O_3$. |
| 0.00 | 0.00769 |
| 1.537 | 0.00332 |
| 2.977 | 0.00233 |
| 4.440 | 0.00182 |
| 5.934 | 0.00172 |
| 7.356 | 0.00150 |
| 8.803 | 0.00167 |
| 10.25 | 0.00195 |
| 11.69 | 0.00217 |

### Solubility of Benzilic Acid in Aqueous Solutions of Sodium Formate at 25°.

(Larsson, 1927.)

| Normality of aq. HCOONa solution | $(C_6H_5)_2COHCOOH$ per liter sat. sol. | |
|---|---|---|
| | Gm. Mols. | Gms. |
| 0.0 (= $H_2O$) | 0.00619 | 1.412 |
| 0.05 | 0.0258 | 5.885 |
| 0.10 | 0.0378 | 8.662 |

### Distribution of Benzilic Acid at 25° Between: (Smith, 1921-1922.)

Water and Chloroform.

| Millimols. $C_{14}H_{12}O_3$ per liter | | |
|---|---|---|
| $H_2O$ layer ($C_1$). | $CHCl_3$ layer ($C_2$). | $\frac{C_2}{C_1}$. |
| 0.2305 | 0.2885 | 1.25 |
| 0.460 | 0.96 | 2.08 |
| 0.604 | 1.75 | 2.74 |

Water and Ether.

| Millimols. $C_{14}H_{12}O_3$ per liter | | |
|---|---|---|
| $H_2O$ layer ($C_1$). | Ether layer ($C_2$). | $\frac{C_2}{C_1}$. |
| 0.050 | 0.83 | 16.60 |
| 0.0775 | 1.55 | 20.00 |
| 0.1200 | 2.72 | 22.65 |
| 0.1600 | 4.44 | 27.7 |
| 0.300 | 9.22 | 30.7 |

Water and Xylene.

| Millimols. $C_{14}H_{12}O_3$ per liter | | |
|---|---|---|
| $H_2O$ layer ($C_1$). | Xylene layer ($C_2$). | $\frac{C_2}{C_1}$. |
| 0.448 | 0.133 | 0.30 |
| 0.757 | 0.363 | 0.479 |
| 1.029 | 0.643 | 0.625 |
| 1.252 | 0.975 | 0.788 |

Freezing-point data for mixtures of *benzimidazol* + Pyramidon are given by Pfeiffer and Angern, 1926.

### Distribution of Benzilic Acid at 25° Between:

(Smith and White, 1929.)

Water and Chloroform

| Gm. Mols. $C_{14}H_{12}O_3$ per liter | |
|---|---|
| $H_2O$ layer | $CHCl_3$ layer |
| 0.00238 | 0.00290 |
| 0.00284 | 0.00363 |
| 0.00323 | 0.00436 |
| 0.00340 | 0.00462 |
| 0.00363 | 0.00500 |
| 0.00374 | 0.00528 |
| 0.00385 | 0.00550 |

Water and Toluene

| Gm. Mols. $C_{14}H_{12}O_3$ per liter | |
|---|---|
| $H_2O$ layer | $C_6H_5CH_3$ layer |
| 0.00112 | 0.00528 |
| 0.00125 | 0.00607 |
| 0.00139 | 0.00674 |
| 0.00178 | 0.00950 |
| 0.00198 | 0.0114 |
| 0.00224 | 0.0128 |
| 0.00251 | 0.0145 |

Freezing-point data for mixtures of benzilic acid and naphthalene are given by Bernoulli and Sarasin, 1930.

## N-ANISAL ANILINE (Anisylidene aniline) $CH_3OC_6H_4CH:NC_6H_5$.

Freezing-point data for mixtures of N-Anisal aniline and benzilidene aniline are given by Pascal, 1923a.

## NITRO DIMETHYL SULPHONIUM (and Selonium) PICRATE $NO_2C_6H_4S(CH_3)_2.C_6H_2(NO_2)_3OH$.

### Solubility of the Isomeric Sulfonium and Selonium Salts in Water at 13°.

(Baker and Moffitt, 1930.)

| Isomeride | Gms. per 100 cc sat. solution | |
|---|---|---|
| | Sulfonium Salt | Selonium Salt |
| p | 0.061 | 0.076 |
| m | 0.050 | 0.050 |
| m + p | 0.165 | 0.105 |

## ACRIFLAVINE (10-chloro methyl, 3,6-diamino acridine-hydrochloride) $C_{13}H_{11}N.CH_3Cl.HCl$.

### Solubility of Mixtures of Acriflavine and the Neutral Hydrochloride of Diamino Acridine in Water at 20°.

(Gaillot, 1934.)

| Gms. per 100 gms. of dry mixture | | Gms. of mixture dissolved per 100 cc saturated solution |
|---|---|---|
| Chloro methylate of diamino acridine | Neutral hydrochloride of diamino acridine | |
| 100 | 0 | 0.4 |
| 80 | 20 | 1.2 |
| 60 | 40 | 2.1 |
| 50 | 50 | 2.3 |
| 40 | 60 | 2.1 |
| 20 | 80 | 1.6 |
| 0 | 100 | 0.8 |

The above experiments and similar ones made with other mixtures show that acriflavine does not possess the solubility and other properties mentioned by the British Pharmacopoeia. Analyses of samples purchased as the chlor methylate contained only 55 to 70 percent of this product. The experiments made with various mixtures of acriflavine and diamino acridine show that those containing from 45 to 55 percent of the hydrochloride of the chloro methylate of diamino acridine correspond in solubility with the figure given in the British Pharmacopoeia. The pure compound is considerable less soluble than commercial samples.

**BIBENZYL** $C_6H_5CH_2CH_2C_6H_5$.

100 gms. sat. solution of Bibenzyl in liquid sulfur dioxide contain 28 gms. $C_{14}H_{14}$ at ? t°. (DeCarli, 1927.)

Freezing-point data are given for mixtures of Bibenzyl and:

Azobenzene(7)(2)(9)(10)
Benzal aniline(7)
Benzoin(8)
Benzo phenone(6)
Benzyl phenol(7)
Biphenyl(5)
Diphenyl disulfide(3)
Hydrazo benzene(7)
Nitro toluene(6)
Phenyl benzyl ether(7)
Picric acid(4)
Stilbene(1)(2)(7)
Styphnic acid(4)
Tolan(7)

Results for mixtures of Bibenzyl β Naphthylamine and Sarcosine anhydride are given by (4)

(1) Bruni, 1898; (2) Garelli and Calzolari, 1899; (3) Grimm, Gunther and Titus, 1931; (4) Jefremow, 1918, 1919, 1919a; (5) Lee and Warner, 1935; (6) Malotaux and Straub, 1937; (7) Pascal and Normand, 1913; (8) Vanstone, 1913; (9) Bruni and Gorni, 1899; (10) Hasselblatt, 1913.

**BENZYL SULFIDE** $(C_6H_5CH_2)_2S$.

100 gms. $CHCl_3$ dissolve 133.91 gms. $(C_6H_5CH_2)_2S$ at 20°.
" " $CCl_4$ " 73.16 " " " " " " " (Pawlewski, 1914.)

**BI TOLYL** $CH_3C_6H_4C_6H_4CH_3$.

Freezing-point data are given by Grimm, Gunther and Titus, 1931, for mixtures of Bitolyl with benzidine, with dichloro biphenyl and with biphenol.

**AZOTOLUENE** $CH_3C_6H_4N{:}NC_6H_4CH_3$.

Freezing-point data are given by Pascal and Normand, 1913, for mixtures of azotoluene with azobenzene and with stilbene.

**CYSTINE** $/C_{11}H_{14}N_2O$.

100 cc. sat. sol. of cystine in water contain 0.0168 gm. $C_{11}H_{14}N_2O$ at 21°.
" in 0.02 mol. $(NH_4)_2SO_4$ " 0.0054 " "

The method followed by Pfeiffer and Angern, 1924, in making the above determinations is described under Alanine, p. 199

## CYSTINE

Solubility of Cystine in Various Aqueous Solutions of Different Hydrogen Ion Concentration at 25°. (Sano, 1926.)

The desired $p_H$ value of the solution was always secured with only such acids and bases as form easily soluble salts with the amino acid. In all cases the solid phase was the amino acid. A large excess of cystine was shaken at 25° with the solvent and the sat. solution, after filtration, was used for the determination of $p_H$ by means of the hydrogen electrode and of the dissolved amino acid by a nitrogen determination.

| Solvent. | $p_H$ of sat. sol. | Gms. N per liter sat. sol. |
|---|---|---|
| Aq. 0.333 *n* HCl..... | 0.83 | 1.565 |
| » 0.100 » » ..... | 1.15 | 0.3861 |
| » 0.020 » » ..... | 1.70 | 0.05275 |
| » 0.010 » » ..... | 2.10 | 0.02770 |
| » 5.0 *n* $CH_3COOH$ +0.10 *n* $CH_3COONa$.. | 2.99 | 0.01310 |
| Aq. 1.0 *n* $CH_3COOH$ +0.20 *n* $CH_3COONa$.. | 3.76 | 0.01278 |
| Aq. 0.1 *n* $CH_3COOH$ +0.1 *n* $CH_3COONa$... | 4.59 | 0.01310 |
| Aq. 0.1 *n* $CH_3COOH$ +2.0 *n* $CH_3COONa$... | 5.88 | 0.0135 |
| Aq. 0.333 mol. sec. phosphate +0.333 » prim. » | 7.52 | 0.0193 |
| Aq. 0.33 mol. sec. phosphate. | 7.98 | 0.0276 |
| » 0.005 *n* NaOH ... | 8.55 | 0.0623 |
| » 0.01 » » ... | 8.78 | 0.1017 |
| » 0.02 » » ... | 9.05 | 0.1924 |
| » 0.10 » » ... | 9.85 | 1.4590 |

The solubility minimum is at $p_H$ 3.76 and the sat. solution contains 0.01278 gm. N, corresponding to 0.1097 gm. cystine.

## HYDROBENZOIN $C_6H_5CHOH.CHOHC_6H_5$.

Freezing-point data for mixtures of the isomeric hydrobenzoins are given by Böseken and Elsen, 1928, and by Read and Steele, 1927.

## AZOANISOLE $C_6H_4OCH_3N.NC_6H_4OCH_3$.

Freezing-point data for mixtures of p Azoanisole with azoxyanisole, with azoanisol phenetol, with azo phenetol and with methyl propyl azophenol are given by Bogojawlausky and Winogrodow, 1907.

## p AZOXYANISOLE $(C_6H_3OHOCH_3)_2N_2$

Freezing-point data are given for mixtures of p azoxyanisole and:

p Azoanisole(1)
p Azoanisole phenol(1)
p Azoxy phenetol(4)(5)
Benzene(2)
Benzo phenone(3)
Ethylene bromide(2)
Hydroquinone(3)
p Methoxy cinnamic acid(3)
Nitro benzene(2)
p oxybenzal p anisidine acetate(6)

(1) Bogojawlawski and Winogrodow, 1907; (2) Bogojawlawski, Winogrodow and Bogolubow, 1906; (3) de Kock, 1904; (4) Prins, 1909; (5) Ratinjanz and Rotaiski, 1906; (6) Robberecht, 1938.

**METHYL ORANGE** $(CH_3)_2NC_6H_4N:NC_6H_4SO_3Na$.

SOLUBILITY OF METHYL ORANGE IN WATER AT 18°.
(von Euler and Rudberg, 1924.)

| pH of the solution | Gm. Mol. Methyl Orange per liter | pH of the solution | Gm. Mol. Methyl Orange per liter |
|---|---|---|---|
| 5.0 | 0.00022 | 3.6 | 0.00004 |
| 4.2 | 0.00010 | 2.5 | 0.00003 |
| 4.0 | 0.00005 | 1.1 | 0.000042 |

The authors also found that one liter of an aqueous 0.02 normal solution of glycocoll dissolves 0.00032 gm. mol. (= 0.0966 gm.) methyl orange at 17.5°.

**DI p TOLYL AMINE** $(CH_3C_6H_4)_2NH$.

Freezing-point data for mixtures of di p tolyl amine and phenyl p tolyl amine are given by Chapman and Perrott, 1930.

**6-AMINO, 3,4'-DIMETHYL AZOBENZENE** $CH_3C_6H_4N:NC_6H_3(CH_3)NH_2$.

Freezing-point data for mixtures of 6, Amino, 3,4-dimethyl azobenzene and sarcosine anhydride are given by Pfeiffer, Angern, Wang, Seydel and Quehl, 1930.

**p DIMETHYL AMINO AZOBENZENE** $(CH_3)_2NC_6H_4N:NC_6H_5$.

Experiments showing the distribution of p dimethyl amino azobenzene between aqueous solutions of sodium salts of fatty acids (soaps)+ether, and of the effect of varying concentrations of methyl alcohol upon this distribution, are given by Smith, 1932a.

100 cc sat. solution of p dimethyl amino azobenzene in ethyl ether contain 2.99 gms. $C_{14}H_{15}N_3$ at 15.5°.

The following results are also given of the solubility of p dimethyl amino azobenzene in aqueous solutions of methyl alcohol.

| Percent $CH_3OH$ in aq. solvent | Gms. $C_{14}H_{15}N_3$ per liter | Percent $CH_3OH$ in aq. solvent | Gms. $C_{14}H_{15}N_3$ per liter |
|---|---|---|---|
| 0 | 0.00032 | 20 | 0.00195 |
| 5 | 0.00041 | 30 | 0.00335 |
| 15 | 0.0010 | 40 | 0.0102 |

Freezing-point data for mixtures of p dimethyl amino azobenzene with m dinitro benzene, with p nitro toluene, with 2,4-dinitro toluene and with 2,4,6-tri nitro toluene are given by Giua and Reggiani, 1925.

**N-METHYL p TOLUENE SULFON ANILIDE** $CH_3C_6H_4SO_2N(CH_3)C_6H_5$.

SOLUBILITY OF N-METHYL p TOLUENE SULFON ANILIDE IN AQUEOUS SOLUTIONS OF ACETIC ACID.

(Bradfield and Williams, 1929.)

(See Benzanilide p. 725)

| Gms. $CH_3COOH$ per 100 gms. aq. solvent | Gms. $CH_3C_6H_4SO_2N(CH_3)C_6H_5$ dissolved per 100 gms. solvent at: | | | |
|---|---|---|---|---|
| | 20° | 25° | 30° | 35° |
| 0.0 | Almost insolubile | | | |
| 26.9 | 0.02 | — | — | — |
| 52.4 | 0.18 | — | — | — |
| 76.8 | 1.83 | 2.36 | 3.05 | 3.94 |
| 85.0 | 3.6 | 4.4 | 5.7 | 7.4 |
| 91.3 | 5.6 | 6.9 | 8.9 | 11.8 |
| 99.0 | 9.0 | 11.2 | 14.3 | 19.2 |

**DIBENZYL HYDRAZINE** $C_6H_5CH_2.NH\text{-}NHCH_2C_6H_5$.

Freezing-point data for mixtures of dibenzyl hydrazine with benzalazine and with cinnamylidene aniline are given by Pascal, 1914.

**DIMETHOXY BENZIDINE** $3,3'[CH_3ONH_2C_6H_3]_2$.

Freezing-point data for mixtures of dimethoxy and diethoxy benzidines are given by Ingold and Kidd, 1933.

**AMYL CUMARIC** (and Cumarinic) **ACID** i $C_{14}H_{18}O_3$.

One liter sat. sol. of Amyl cumaric acid in $H_2O$ contains 0.0197 gms. $C_{14}H_{18}O_3$ at 25°.

One liter sat. sol. of Amyl cumarinic acid in $H_2O$ contains 0.113 gms. $C_{14}H_{18}O_3$ at 25°. (Roth and Stoermer, 1913.)

**ACETYLENE ETHYL TETRA CARBONATE** $[CH(CO_2C_2H_5)_2]_2$.

Freezing-point data for mixtures of acetylene ethyl tetra carbonate with ethylene cyanide are given by Timmermans and Mme. Vesselovsky, 1931.

**UNDECYL MALONIC ACID** $CH(C_{11}H_{22})(COOH)_2$.

100 gms. $C_6H_6$ dissolve 0.0139 gm. $CH(C_{11}H_{23})(COOH)_2$ at 25°. (Verkade and Coops, Jr., 1930a.)

**ETHYL SEBACATE** $(CH_2)_8(COOC_2H_5)_2$.

100cc $H_2O$ dissolve 0.008 gm. $(CH_2)_8(COOC_2H_5)_2$ at 20°. (Sobotka and Kahn, 1931.)

**MYRISTIC ACID** $CH_3(CH_2)_{12}COOH$.

The melting-point depressions of mixtures of myristic and other fatty acids as a method of estimating the percentages of individual fatty acids in mixtures are reported by Wenzel, 1934.

Results for the freezing-points of mixtures of myristic and palmitic acids are given by Kulka and Sandin, 1937.

**TRIMYRISTIN** $C_3H_5[CH_3(CH_2)_{12}COO]_3$.

SOLUBILITY OF TRIMYRISTIN IN SEVERAL SOLVENTS.
(Loskit, 1928.)

The determinations were made by the thermic, the sealed tube and the analytical method. The author's results were plotted and the following table constructed from the curves.

| $t^0$ | Gms. $C_3H_5[CH_3(CH_2)_{12}COO]_3$ per 100 gms. sat. solution in: | | | |
|---|---|---|---|---|
| | $C_6H_6$ | $(C_2H_5)_2O$ | $CHCl_3$ | $CS_2$ |
| 0 | — | — | 10.0 | 0.5 |
| 5 | 5.0 | 0.4 | 15.0 | 1.6 |
| 10 | 5.0 | 1.0 | 21.0 | 5.0 |
| 15 | 13.5 | 2.5 | 27.5 | 12.5 |
| 20 | 25.0 | 6.5 | 34.0 | 24.0 |
| 25 | 36.0 | 15.0 | 41.5 | 36.0 |
| 30 | 47.5 | 31.5 | 49.0 | 49.0 |
| 35 | 60.0 | 49.5 | 58.0 | 60.0 |
| 40 | 71.0 | 64.0 | 67.0 | 70.0 |
| 45 | 80.0 | 76.5 | 76.0 | 79.0 |
| 50 | 89.0 | 88.0 | 86.5 | 89.0 |

**PHENACYL MYRISTATE** $CH_3(CH_2)_{12}COO.CH_2COC_6H_5$ etc.

SOLUBILITY OF PHENACYL, BROMO PHENYLACYL AND CHLORO PHENYLACYL MYRISTATES IN 95% ETHYL ALCOHOL.
(Hann, Reid and Jameson, 1930.)

| Myristate | Formula | Gms. Myristate per 100cc 95% alcohol at | |
|---|---|---|---|
| | | $20^0$ | $25^0$ |
| Phenacyl Myristate | $CH_3(CH_2)_{12}COO.CH_2COC_6H_5$ | 1.698 | 1.749 |
| p Bromo " | $CH_3(CH_2)_{12}COOCH_2COC_6H_4Br$ | 0.160 | 0.2092 |
| p Chloro " | $CH_3(CH_2)_{12}COOCH_2COC_6H_4Cl$ | 0.2472 | 0.3071 |

**FLAVONE** $C_6H_4OC(C_6H_5):CHCO$.

Freezing-point data are given for mixtures of flavone +

Primetine (Ashina, 1933.)
Chrysine(5,6-dioxy flavone)(Ashina and Yokoyama, 1935.)
Tri acetylapigenine(5,7,4-tri acetoxyflavone)(Ashina and Yokoyama, 1935.)
Di acetyl primetine(5,6-diacetoxy flavone " " " "
Methyl primetine(5, oxy, 6, methoxy flavone) " " " "
Methyl baicaleine(5,6,7-tri methoxy flavone) " " " "

**METHOXY ANTHRAQUINONE** $C_6H_4(CO)_2C_6H_3OCH_3$.

Freezing-point data for mixtures of methoxy anthraquinone with β Naphthylamine and with p toluylic acid are given by Pfeiffer, Angern, Wang, Seydel and Quehl, 1930.

**QUERCETIN** $C_{15}H_{10}O_7.2H_2O$ (m. pt. 310°-311°).

**QUERCETRIN** $C_{21}H_{20}O_{11}$(m.pt.174°-176°)(The yellow glucoside of Loranthus).

Solubility of Each Separately in Several Solvents at 16°.
(Wester, 1921.)

The quercetin was prepared by hydrolysis of quercetrin in 3 per cent sulfuric acid.

| Solvent. | Gms. per 100 gms. sat. sol. Quercetin. | Quercetrin. |
|---|---|---|
| Water | 0.006 | 0.0064 |
| Aq. 49 % alcohol | 0.029 | 0.894 |
| Aq 95 % alcohol | 1.419 | 4.040 |
| Ether (commercial) | 0.211 | 0.006 |
| Methyl Alcohol | 1.30 | 8.94 |
| Aq. 50 vol. % methyl alcohol | 0.027 | 0.275 |
| Ethyl Acetate | – | 0.070 |

**1-AMINO, 2-METHYL ANTHRAQUINONE** $CH_3C_6H_3(CO)_2C_6H_3NH_2$.

Freezing-point data for mixtures of 1-amino, 2-methyl anthraquinone and 1-chloro, 2-methyl anthraquinone are given by Grimm, Gunther and Titus, 1931.

**CHALCONE** (Benzal aceto phenone) $C_6H_5CH:CHCOC_6H_5$.

Freezing-point data are given for mixtures of Chalcone and:

Naphthols (Giua, 1916.)
Nitro phenols (Asahina, 1934.)

**OXY CHALCONE** (2' and 4' Oxy benzal aceto phenone) $C_6H_4(OH)CH:CHCOC_6H_5$.

Freezing-point data for mixtures of 2' and 4' Oxy benzal acetophenone with 2,4,6-tri nitro phenol are given by Asahina, 1934.)

**CINNAMYLIDENE ANILINE** $C_6H_5CH{:}CH.CH{:}NC_6H_5$.

Freezing-point data for mixtures of cinnamylidene aniline with benzalazine with dibenzyl hydrazine, with diphenyl butadien and with diphenyl diacetylene are given by Pascal, 1914.

**DIBENZYL ACETONE** $(C_6H_5CH_2)_2CO$.

Freezing-point data for mixtures of dibenzyl acetone and chloro acetic acid are given by Kendall and Gibbons, 1915.

**METHYL DESOXY BENZOIN** $C_6H_5CH(CH_3)COC_6H_5$.

Freezing-point data for mixtures of methyl desoxy benzoin and benzoin are given by Preiswerk and Erlenmeyer, 1934.

**BENZYL CARBONATE** $(CH_2C_6H_5)_2CO_3$.

Freezing-point data for mixtures of benzyl carbonate and nitrite are given by Erlenmeyer and Leo, 1933.

**GUAIACOL CARBONATE** $[C_6H_4(OCH_3)O]_2CO$.

SOLUBILITY IN WATER, ALCOHOL, ETC. (U. S. P. VIII.)

| Solvent. | t°. | Gms. per 100 Gms. Solvent. | |
|---|---|---|---|
| | | Guaiacol. | Guaiacol Carbonate. |
| Water | 25 | 1.89 | ... |
| Alcohol | 25 | ... | 2.08 |
| Chloroform | 25 | ... | 66.6 |
| Ether | 25 | ... | 7.69 |
| Glycerol | 25 | 100 | ... |

The coefficient of distribution of guaiacol carbonate between olive oil and water at 25° is given as $\frac{S_{oil}}{S_w} = 3.7$ by Boëseken and Waterman, 1911, 1912.

**ANISAL AMINO ACETOPHENONE** $C_{15}H_{15}O_2N$.

Freezing-point data are given by Robberecht, 1938, for mixtures of anisal amino acetophenone with p azoxy phenol ethyl carbonate and with cholesterol propionate.

**DIMETHYL DIPHENYL UREA** $N(CH_3)_2N(C_6H_5)_2.CO$.

Freezing-point data for mixtures of dimethyl diphenyl urea with nitro mannitol, with nitro penta erythritol and with tri methylene tri nitramine are given by Urbanski, 1933, and Urbanski and Rabek-Gawronska, 1934.

**DI TOLYL THIO UREA** o $(CH_3C_6H_5NH)_2CS$.

100 gms. $CCl_4$ dissolve 0.10 gm. $C_{15}H_{18}SN_2$ at 20°.
" " $CHCl_3$ " 9.54 " " " " " (Pawlewski, 1914, 1926.)

**SANTONIN** $C_{15}H_{18}O_3$.

SOLUBILITY IN SEVERAL SOLVENTS.

| Solvent | t° | Gms. $C_{15}H_{18}O_3$ per 100 Gms. Solvent | Authority |
|---|---|---|---|
| Water | 20–25 | 0.02+ | (Dehn, 1917.) |
| Alcohol (90%) | 15 | about 2.3 | (Greenish and Smith, 1903.) |
| Trichlor Ethylene | 15 | 2.46 | (Wester and Bruins, 1914.) |
| Pyridine | 20–25 | 12.72 | (Dehn, 1917.) |
| Aq. 50% Pyridine | 20–25 | 12.35 | " " |
| Benzene | 25 | 5.2 | (Warren, 1933.) |
| $CCl_4$ | 25 | 0.3 | " " |
| Pet. Ether | 25 | 0.015 | " " |

Freezing-point data for mixtures of stereoisomeric santonin salts are given by Levi-Malvano and Mannino, 1908.

**BENZENE TRIETHYL CARBOXYLATE** $1,3,5\text{-}(CO_2C_2H_5)_3C_6H_3$.

Freezing-point data for mixtures of benzene tri ethyl carboxylate with 1,3,5 trizazine tri carbonic acid tri ethyl ester and with 1,3,5 tri phenyl tri azine are given by Pascal, 1925.

**$\beta$ EUCAINE** $C_{15}H_{21}NO_2$ and Salts.

100 cc. $H_2O$ dissolve 0.296 gm. anhydrous $\beta$ eucaine at 20°. } (Zalai, 1910.)
100 cc. oil of sesame dissolve 3.49 gms. anhydrous $\beta$ eucaine at 20°. } (Zalai, 1910.)
100 cc. aniline oil dissolve 66.6 gms. anhydrous $\beta$ eucaine at 20°.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 100 cc. $H_2O$ | dissolve | 2.5 gms. | $\beta$ eucaine | hydrochloride | at 15–20° | (Squire and Caines, 1905.) |
| 100 cc. 90% alcohol | " | 9 | " | " | " | " | |
| 100 cc. $H_2O$ | " | 25 | " | lactate | " | " | |
| 100 cc. 90% alcohol | " | 12.5 | " | " | " | " | |
| 100 cc. $CHCl_3$ | " | 20 | " | " | " | " | |

**PHYSOSTIGMINE** (Eserine) $C_{15}H_{21}N_3O_2$.

Water dissolves only traces of physostigmine. 100 gms. of a solvent composed of 3 gms. $H_3BO_3$ per 100 cc. of aq. 50% glycerol dissolve 2.5 gms. $C_{15}H_{21}N_3O_2$ at room temp. (Baroni and Borlinetto, 1911.)

**PHYSOSTIGMINE SALICYLATE** $C_6H_4(OH)COOH.C_{15}H_{21}N_3O_2$ and Physostigmine Sulfate $H_2SO_4(C_{15}H_{21}N_3O_2)_2$.

SOLUBILITY OF EACH IN WATER, ALCOHOL, ETC. (U. S. P. VIII.)

| Solvent. | t°. | Gms. per 100 Gms. Solvent. Salicylate. | Sulfate. |
|---|---|---|---|
| Water | 25 | 1.38 | very soluble |
| Water | 80 | 6.66 | " |
| Alcohol | 25 | 7.87 | " |
| Alcohol | 60 | 25 | " |
| Chloroform | 25 | 11.6 | |
| Ether | 25 | 0.57 | 0.083 |

## SPARTEINE $C_{15}H_{26}N_2$.

### Solubility of Sparteine in Water and in Aqueous 5 per cent Solutions of Sodium Carbonate. (Valeur, 1917, 1919.)

The temperatures were determined at which clouding occurs in solutions of sparteine in water and in aqueous 5% $Na_2CO_3$ solutions. Recently distilled sparteine of rotation $-2°\ 46'$ in a 5 dcm tube was used.

| Results for water | | Results for Aq. 5 % $Na_2CO_3$ solutions | | | |
|---|---|---|---|---|---|
| t° of clouding. | Gms. $C_{15}H_{26}N_2$ per 100 cc. sat. sol. | t° of clouding | Gms. $C_{15}H_{26}N_2$ per 100 cc. sat. sol. | t° of clouding. | Gms. $C_{15}H_{26}N_2$ per 100 cc. sat. sol. |
| 10.8..... | 0.556 | 23.4..... | 0.21 | 39.8..... | 0.12 |
| 12.5..... | 0.496 | 24.0..... | 0.19 | 43.5..... | 0.105 |
| 18.0..... | 0.32* | 25.0..... | 0.18 | 47.0..... | 0.09 |
| 22.0..... | 0.31 | 28.6..... | 0.165 | 53.0..... | 0.075 |
| 32.0..... | 0.28 | 33.5..... | 0.15 | 60.2..... | 0.060 |
| 38.0..... | 0.20 | 36.5..... | 0.135 | 72.5..... | 0.045 |
| 50.0..... | 0.18 | | | | |

*This determination made by direct saturation and analysis of the solution by precipitation of the sparteine as picrate or phosphotungstate.

## SPARTEINE SULFATE $C_{15}H_{26}N_2.H_2SO_4.5H_2O$.

100 gms. $H_2O$ dissolve about 200 gms. sparteine sulfate at 15–20°.
100 cc. 90% alcohol dissolve about 20 gms. sparteine sulfate at 15–20°.
(Squire and Caines, 1905.)

## NAPHTHALENE PICRATE $C_6H_2(NO_2)_3O.C_{10}H_7$.

### Solubility of Naphthalene Picrate in Benzene and in Tetraline. (Platti, 1931.)

The results are given in the form of a diagram from which the following values were taken.

| t° | Gms. $C_6H_2(NO_2)_3O.C_{10}H_7$ per 100 gms. sat. solution in: | |
|---|---|---|
| | $C_6H_6$ | Tetralin ($C_{10}H_{12}$) |
| 5 | 8.1 | — |
| 10 | 9.2 | 3.6 |
| 20 | 12.7 | 5.8 |
| 30 | 17.0 | 8.6 |
| 40 | 24.6 | 12.3 |
| 45 | 29.5 | — |
| 50 | — | 17.3 |
| 60 | — | 24.0 |

Freezing-point data for mixtures of naphthalene picrate and methyl naphthalene picrate are given by Meyer and Meyer, 1919.

## PYRENE $C_{16}H_{10}$

### Solubility in Toluene and in Absolute Alcohol.

100 gms. toluene dissolve 16.54 gms. pyrene at 18°.
100 gms. absolute alcohol dissolve 1.37 gms. pyrene at 10° and 3.08 gms. at b. pt.

**DIPHENYL BIACETYLENE** (Diphenyl butadiyne) $C(C_6H_5):CC:C(C_6H_5)$.

Freezing-point data for mixtures of diphenyl biacetylene with benzaldehyde and with diphenyl butadien are given by Pascal, 1914.

Freezing-point data for mixtures of diphenyl diacetylene and cinnamylidene aniline are given by Pascal, 1914.

**FLUORANTHENE** $C_{16}H_{10}$.

Freezing-point data are given by Shinomiya, 1940, for mixtures of fluoranthene and each of the following compounds: dinitro phenol, dinitro toluene, picramide, picryl chloride, trinitro anisole, trinitro benzene, trinitro cresol and trinitro toluene.

**INDIGO** $(C_6H_4\langle^{CO}_{NH}\rangle C:)_2$.

100 gms. 95% formic acid dissolve 0.14 gm. indigo at 19.8°. (Aschan, 1913.)

**CONGO RED** $[C_6H_4.N:N.C_{10}H_5(NH_2)SO_3Na]_2$.

100 gms. $H_2O$ dissolve 11.6 gms. congo red at 20°–25°. (Dehn, 1917.)
100 gms. pyridine dissolve 0.29 gm. congo red at 20°–25°. "
100 gms. aq. 50% pyridine dissolve 7.32 gms. congo red at 20–25°. "

**DIBENZOYL ETHYLENE** cis and trans $C_6H_5COCH:CHCOC_6H_5$.

Freezing-point data for mixtures of cis and of trans dibenzoyl ethylene with azodibenzoyl are given by Grimm, Gunther and Titus, 1931.

**ATOPHAN** (Cinchophen) Phenylcinchoninic Acid (2)$(C_6H_5).C_9H_6N.(4)COOH$.

Solubility in Several Solvents at 25°. (Leech, Rabak and Clark, 1919.)

| Solvent. | Gms. Atophan per 100 gms. sat. sol. |
|---|---|
| Water | 0.0160 |
| 95 % Ethyl alcohol | 0.8343 |
| 48.5 % " | 0.0875 |
| Chloroform | 0.1075 |
| Ethyl acetate (81.6 %) + alcohol, etc. (10 %) | 1.4151 |

**METHYLENE DIOXY BENZAL ACETOPHENONE** (Methyl dioxy chalcone) $3,4\text{-}CH_2O_2C_6H_3CH:CHCOC_6H_5$.

Freezing-point data are given by Asahina, 1934, 1934a, for mixtures of methylene dioxy benzal accto phenone and each of the following compounds: β Naphthol, o, m and p Nitrophenols, o Nitro toluene, 2,4,6-trinitro phenol and 2,4,6 Trinitro toluene.

**PHENYL VERONAL** (Barbital) $\underline{NHCONHCOC(C_6H_5)_2}CO$.

100 gms. benzene dissolve 0.057 gm. barbital at 25°. (Warren, 1933.)
" " $CCl_4$ " 0.007 " " " " " "

Freezing-point data for mixtures of phenyl veronal with antipyrine, with pyramidon, and with sarcosine anhydride are given by Pfeiffer and Seydel, 1928a.

**PIPERONAL ACETO PHENONE** $CH_2O_2C_6H_3CH:CHCOC_6H_5$.

Freezing-point data for mixtures of piperonal acetophenone and p iodo biphenyl are given by Pfeiffer, Schmitz and Inoue, 1929.

**METHYL DIPHENYL TRIAZINE** $CH_3(C_6H_5)_2C_3N_3$.

Freezing-point data for mixtures of methyl diphenyl triazine with 1,3,5, triphenyl benzene and with 1,3,5-triphenyl triazine are given by Pascal, 1925.

**α BROMO β METHOXY BENZAL ACETO PHENONE** $C_6H_5COCBr{:}C(OCH_3)C_6H_5$

SOLUBILITY OF THE ISOMERS, A AND B
EACH SEPARATELY, IN LIGROIN AND IN ETHYL ALCOHOL.
(Dufraisse and Gillet, 1929.)

| Solvent | t° | Gms. per 100 gms. sat. sol. Isomer A (m.pt.102°) | Isomer B (m.pt.71-72°) |
|---|---|---|---|
| Ligroin (b.pt. 80°-85°) | 19 | 2.84 | 2.24 |
| Ethyl Alcohol | 19 | 9.9 | 6.1(17°) |

**BENZOYL TETRA HYDRO QUINALDINE**

Freezing-point data for mixtures of the d and l form are given by Adriani, 1900.

**VINYL PHENYL CARBINOL p NITRO BENZOATE** $C_6H_5CHO(COC_6H_4NO_2)CH{=}CH_2$.

Freezing-point data are given for mixtures of Vinyl phenyl carbinol p nitro benzoate +

Cinnamic p nitro benzoate (Meisenheimer and Schmidt, 1933.)
Cinnamic, 3,4,5-tri bromo benzoate (Meisenheimer and Schafer, 1933.)

**DIPHENYL BUTADIENE**

Freezing-point data are given for mixtures of diphenyl butadiene and:

Benzalazine (Pascal, 1914.)
Diphenyl acetylene " "
Diphenyl hydrazine " "
Dimethyl fumerate (Kuhn and Wagner-Jauregg, 1929.
Picryl chloride " " " "
Cinnamylidene aniline (Pascal, 1914.)
" β naphthylamine " "

**DIBENZOYL ETHANE** $(C_6H_5COCH_2)_2$.

Freezing-point data for mixtures of 1,2 dibenzoyl ethane with 1,2 dibenzyl hydrazine and with benzoyl superoxide are given by Grimm, Gunther and Titus, 1931.

**DIMETHOXY STILBENE** pp' $(CH_3OC_6H_4CH)_2$.

Results for the freezing-points of mixtures of dimethoxy stilbene and tetra methyl diamino benzophenone(Michler's ketone) are given by Pfeiffer, 1924, and Pfeiffer, Goebel and Angern, 1925.

**DIXYLYL AMINE** $(C_6H_3(CH_3)_2)_2N$.

Freezing-point data for mixtures of dixylyl amine with cresols are given by Morgan and Pettet, 1935.

**METHYLENE BLUE** $(CH_3)_2N.C_6H_3(NS)C_6H_3:N(CH_3)_2Cl$.

100 gms. $H_2O$ dissolve 4.36 gms. methylene blue at 20–25°. (Dehn, '17.)
" pyridine " 0.26 " " " "
" aq. 50% pyridine " 0.74 " " " "

Data for the distribution of methylene blue between aniline and water are given by Pelet-Jolivet (1909).

100 gms. sat. solution of methylene blue in water contain 2.3 gm. of the anhydrous compound at 25°. The solid phase in contact with water and with aqueous alcohol retains approximately 17% $H_2O$, corresponding to 4 molecules of $H_2O$ of crystallization. Attempts to reach equilibrium from supersaturation were unsuccessful since the excess solid continued to separate even after 38 days.

100 gms. sat. solution of methylene blue in éthyl alcohol of d = 0.8063 at 25°/4° contain 1.47 gm. of the anhydrous compound at 25°. (Schnellbach and Rosin, 1931.)

**AZOPHENETOL** (p) $(C_2H_5OC_6H_4)_2N_2$.

SOLUBILITY IN 100 PER CENT ACETIC ACID.

(Dreyer and Rotarski — Chem. Centr. 76, II, 1016, '05.)

| t° = | 89.2 | 91 | 93 | 95.6 | 97.2 | 99.6 |
|---|---|---|---|---|---|---|
| Mols. per liter. | 0.153 | 0.176 | 0.185 | 0.209 | 0.232 | 0.252 |

A break in the curve at 94.7° corresponds to the transition temperature of the $\alpha$ modification into the $\beta$ modification.

Freezing-point data are given for mixtures of azo phenetol and

Anisal azoxy phenetol (Rotinjanz and Rotarsky, 1906.)
p Azoanisole (Bogojawlousky and Winogradow, 1907.)
p Azoanisol phenetol " " " "
p Azoxy phenetol " " " "
Di propyl azo phenetol " " " "

p **AZOXY PHENETOL** $(C_2H_5O(OH)C_6H_3)_2N_2$.

Freezing-point data are given for mixtures of p Azoxy phenetol and:

Azo anisol phenetol (Bogojawlousky and Winogradow, 1907.)
Azo phenetol " " " "
Azoxy anisole (Prins, 1909; Rotinjanz and Rotarsky, 1906.)
Cholesterine benzoate (Prins, 1909.)
" iso butyrate " "
" propionate " "
Methoxy cinnamic acid " "

## PHENYL ETHYL AMINE MANDELATES etc. $C_{16}H_{19}O_3N$.

### Solubilities of Optically Isomeric Salts in Water.

(Ingersoll, Babcock and Burns, 1933.)

| Optically active salt | m.pt. | t° | Gms. salt dissolved per 100 gms. $H_2O$ |
|---|---|---|---|
| d-α Phenyl ethyl amine-l-mandelate(1) | 177 | 30 | 4.91 |
| d-α " " " -d- " | — | 30 | 18.0 |
| dl-α " " " -d- " | 176 | 30 | 5.81 |
| dl-α " " " -dl- " | 138 | 30 | 12.29 |
| dl-α p Tolyl ethyl amine-dl-mandelate(2) | 136 | 25 | 4.89 |
| d-α " " " -l- " | 146 | 25 | 5.18 |
| d-α " " " -d- " | 140 | 25 | 7.12 |
| l-α Phenyl ethyl amine-d-α-bromo camphor π sulfonate(3) | 205 | 25 | 5.40 |
| dl-α " " " -dl-α " " | 155 | 25 | 2.05 |
| d-α " " " -dl-α " " | 170 | 25 | 3.11 |
| α p Tolyl ethyl amine-α- " " (4) | 165 | 25 | 2.10 |
| " " " " " " | 232 | 25 | 2.96 |
| d-α " " " d-α " " | 165 | 25 | 2.12 |
| dl-α " " " dl-α " " | 161 | 25 | 3.38 |

(1) $C_{16}H_{19}O_3N$, (2) $C_{17}H_{21}O_3N$, (3) $C_{18}H_{26}O_4NSBr.H_2O$, (4) $C_{19}H_{28}O_4NSBr.H_2O$.

## DIETHOXY BENZIDINE $[C_2H_5O(NH_2)C_6H_3]_2$.

Freezing-point data for mixtures of diethoxy and dimethoxy benzidines are given by Ingold and Kidd, 1933.

## HOMATROPINE HYDROBROMIDE $C_{16}H_{21}NO_3.HBr$.

### Solubility in Water, etc.

(U. S. P. VIII.)

100 gms. water dissolve 17.5 gms. salt at 25°.
100 gms. alcohol dissolve 3.08 gms. salt at 25°, and 11.5 gms. at 60°.
100 gms. chloroform dissolve 0.16 gm. salt at 25°.

## PALMITIC ACID $CH_3(CH_2)_{14}COOH$.

### Solubility in Aq. and Absolute Ethyl Alcohol.

(Falciola, 1910.)

| t°. | Gms. $CH_3(CH_2)_{14}COOH$ per 100 cc.: Absolute Alcohol. | Aq. 75% Alcohol. | Aq. 50% Alcohol. |
|---|---|---|---|
| 10 | 2.8 | 0.24 | 0.05 |
| 20 | 9.2 | 0.43 | 0.08 |
| 30 | ... | 1.19 | 0.12 |
| 40 | 31.9 | 3.59 | 0.31 |

100 cc. sat. solution of palmitic acid in methyl alcohol of 94.4 vol. % ($d$ = 0.8183) contain 1.03 to 1.17 gms. at 0.2°, equilibrium being approached from above. The mixtures were simply allowed to stand in an ice chest for from 12 to 156 hours.

(Hehner and Mitchell, 1897.)

### Solubility of Palmitic Acid in Several Alcohols.

(Timofeiew, 1894.)

| Alcohol. | t°. | Gms. $CH_3(CH_2)_{14}COOH$ per 100 Gms. Sat. Sol. | Alcohol. | t°. | Gms. $CH_3(CH_2)_{14}COOH$ per 100 Gms. Sat. Sol. |
|---|---|---|---|---|---|
| Methyl Alcohol | 0 | 0.72 | Propyl Alcohol | 0 | 2.92 |
| " | 21 | 5.1 | " | 21 | 13.8 |
| " | 36 | 29.5 | Isobutyl Alcohol | 0 | 2.2 |
| Ethyl Alcohol | 0 | 2 | " | 21 | 12.8 |
| " | 21 | 10.1 | | | |

One hundred gms. of aq. 5% solution of bile salts dissolve about 0.1 gm. palmitic acid. 100 gms. aq. 5% solution of bile salts containing 1% of lecithin dissolve 0.6 gms. palmitic acid. (Moore, Wilson and Hutchinson, 1909.)

### Solubility of Palmitic Acid in Aqueous Ethyl Alcohol.

(Ekwall, and Mylius, 1932.)

| t° | Vol. % $C_2H_5OH$ in aq. solvent | Gms. $CH_3(CH_2)_{14}COOH$ per 100cc solvent | t° | Vol. % $C_2H_5OH$ in aq. solvent | Gms. $CH_3(CH_2)_{14}COOH$ per 100cc solvent |
|---|---|---|---|---|---|
| 7.0 | 70 | 0.09 | 7.0 | 95 | 1.38 |
| 12.5 | " | 0.14 | 12 | " | 1.95 |
| 19.5 | " | 0.32 | 16 | " | 3.09 |
| 24.5 | " | 0.48 | 19 | " | 3.85 |
| 6.5 | 80 | 0.24 | 20 | " | 3.97 |
| 13.0 | " | 0.47 | 8 | 96 | 1.80 |
| 19.0 | " | 0.76 | 12 | " | 2.21 |
| 25.0 | " | 1.45 | 19 | " | 4.60 |
| 6.0 | 90 | 0.82 | 20 | " | 4.74 |
| 12.0 | " | 1.12 | −10 | 99.9 | 0.61 |
| 20.0 | " | 2.48 | 0 | " | 1.56 |
| | | | +17 | " | 5.53 |

### Solubility of Palmitic Acid in Aqueous Ethyl Alcohol at 0°.

(Ku, 1937.)

| Vol. % $C_2H_5OH$ in aq. solvent | Gms. $CH_3(CH_2)_{14}COOH$ per 100 gms. sat. sol. | Vol. % $C_2H_5OH$ in aq. solvent | Gms. $CH_3(CH_2)_{14}COOH$ per 100 gms. sat. sol. |
|---|---|---|---|
| 54.84 | 0.027 | 76.05 | 0.105 |
| 59.61 | 0.041 | 80.33 | 0.165 |
| 70.19 | 0.054 | 90.14 | 0.449 |

## PALMITIC ACID $CH_3(CH_2)_{14}COOH$.

### Solubility of Palmitic Acid in Carbon Tetrachloride and in Carbon Tetrachloride Solutions of Laurinic Acid at 0°.

(Waentig and Pescheck, 1919.)

| Gms. Laurinic Acid per 100 gms. $CCl_4$. | Gms. $CH_3(CH_2)_{14}COOH$ per 100 gms. sat. sol. | Gms. Laurinic Acid per 100 gms. $CCl_4$. | Gms. $CH_3(CH_2)_{14}COOH$ per 100 gms. sat. sol. |
|---|---|---|---|
| 0.0 (= $CCl_4$ alone) | 0.471* | 3.312 | 1.5093 |
| 0.0 " | 0.5457 | 4.296 | 1.7260 |
| 0.984 | 1.0080 | 5.214 | 1.8111 |
| 2.150 | 1.2644 | 5.821 | 1.8579 |

* It appears probable that in this case saturation was approached from below and all the others from above.

## Solubility of Palmitic Acid in Several Solvents at 25°.

(Kröber, 1919.)

| Solvent. | Gms. $CH_3(CH_2)_{14}COOH$ per 100 gms. solvent. | Gms. $CH_3(CH_2)_{14}COOH$ per 100 cc. solvent. | Solvent. | Gms. $CH_3(CH_2)_{14}COOH$ per 100 gms. solvent. | Gms. $CH_3(CH_2)_{14}COOH$ per 100 cc. solvent. |
|---|---|---|---|---|---|
| Methyl formate..... | 2.5 | 2.3 | Methyl butyrate..... | 10.0 | 8.9 |
| » acetate..... | 7.8 | 7.2 | Ethyl » ..... | 10,5 | 9.1 |
| Ethyl » ..... | 10.7 | 9.6 | Propyl » ..... | 10.6 | 9.2 |
| Amyl » ..... | 16.6 | 14.3 | Ethyl ether..... | 32.8 | 23.2 |
| Methyl propionate.. . | 9.9 | 9.0 | » alcohol. ..... | 11.0 | 9.4 |
| Ethyl » .... | 10.5 | 9.3 | » chloracetic acid. | 1.1 | 1.3 |

The author does not describe the method used and does not claim high accuracy for the results.

## Solidification Points of Mixtures of Palmitic and Stearic Acids.

(De Visser, 1898.)

Fifty gram samples of each mixture were used and great care taken to insure accuracy of the determinations.

| t° of Solidification. | Gms. Stearic Acid per 100 Gms. Mixture. | t° of Solidification. | Gms. Stearic Acid per 100 Gms. Mixture. | t° of Solidification. | Gms. Stearic Acid per 100 Gms. Mixture. |
|---|---|---|---|---|---|
| 69.32 | 100 | 57.2 | 55 | 54.85 Eutec. | 30 |
| 67.02 | 90 | 56.42 | 50 | 55.46 | 25 |
| 64.51 | 80 | 56.38 | 45 | 56.53 | 20 |
| 61.73 | 70 | 56.11 | 40 | 59.31 | 10 |
| 58.76 | 60 | 55.62 | 36 | 62.62 | 0 |

Additional determinations on this system by Dubowitz (1911) are, for the most part, in good agreement with the above. According to Carlinfanti and Levi Malvano (1909), however, the eutectic could not be located and there were indications of the existence of solid solutions.

The melting-point depression of mixtures of palmitic, stearic, oleic, myristic and other fatty acids were used by Wenzel, 1934, as a method of estimating the content of individual fatty acids in unknown mixtures.

Freezing-point data are given for mixtures of:

Palmitic acid + Apocholic acid(11)
" " + Arachidic acid(19)
" " + Cholic acid(12)
" " + Desoxy cholic acid (11)
" " + Elaidic(17)
" " + Erythritol(10)
" " + Glycerol(10)
" " + Hydnocarpic acid(1)
" " + Hyodesoxy cholic acid(12)
" " + Iso oleic acid(18)
" " + Linoleic(18)
" " + Mannitol(10)
Palmitic acid + Myristic acid(8)
" " + Margaric acid(13)(16)
" " + Oleic acid(2)(3)(5)(17)(18)
" " + Stearic acid(4)(5)(6)(7)(13)
" " + Tri palmitin(6)(7)
Palmitic acid Cetyl Ester + Paraffin(9)
Palmitic acid ester + Naphthalene(14)
Tri palmitin + Stearic acid(6)
" " + Tri olein(8a)
" " + Tri stearin(6)
Ethyl palmitate + Ethyl Stearate(15)

(1) Cole and Cardoso, 1937; (2) Dubovitz, 1911; (3) Fokin, 1912; (4) Giua, 1916; (5) Jefremow, 1927a; (6) Kremann and Klein, 1913; (7) Kremann and Kropsch, 1914; (8) Kulka and Sandin, 1937; (8a) Kremann and Schoulz, 1912; (9) Palazzo and Battelli, 1883; (10) Puschin and Dezelic, 1932; (11) Rheinboldt, Flume and König, 1929; (12) Rheinboldt and Lauber, 1929; (13) Schriner, Fulton and Burks, 1933; (14) Battelli and Martinelli, 1885; (15) Smith, 1931; (16) Smith, 1936; (17) Smith, 1939; (18) Koczy and Griengl, 1931; (19) von Meyer, Brod and Sozka, 1913.

**PALMITIC ANHYDRIDE** $(C_{15}H_{31}CO)_2O$.

100 gms. abs. alcohol dissolve 0.18 gm. $(C_{15}H_{31}CO)_2O$ at 20°. (Whitby, 1926.)

**PALMITAMIDE** $CH_3(CH_2)_{14}CONH_2$.

Freezing-point data are given by Guy and Smith, 1939, for mixtures of:

Palmitamide + Stearamide
Palmitanilide + Stearanilide
Methyl palmitate + Methyl stearate

**TRI PALMITIN** $C_3H_5[CH_3(CH_2)_{14}COO]_3$.

SOLUBILITY OF TRIPALMITIN IN SEVERAL SOLVENTS.
(Loekit, 1928.)

The determinations were made by the thermic, the sealed tube and the analytical method. The author's results were plotted and the following table constructed from the curves.

| t° | Gms. $C_3H_5[CH_3(CH_2)_{14}COO]_3$ per 100 gms. sat. solution in: $C_6H_6$ | $(C_2H_5)_2O$ | $CHCl_3$ |
|---|---|---|---|
| 5 | — | — | 4.5 |
| 10 | — | — | 8.5 |
| 15 | 2.5 | — | 14.0 |
| 20 | 6.7 | 0.7 | 20.0 |
| 25 | 13.5 | 2.4 | 27.0 |
| 30 | 25.0 | 6.5 | 34.0 |
| 35 | 39.0 | 15.5 | 41.5 |
| 40 | 51.0 | 32.2 | 50.0 |
| 50 | 72.5 | 70.5 | 68.0 |
| 60 | 90.0 | 90.0 | 88.0 |

**β BUTYRO** Dipalmitin (β Butyryl αα′-dipalmityl glyceride) $C_{41}H_{74}O_6$.

100 gms. absolute ethyl alcohol dissolve 0.55 gm. of the cmpd at. 20°. (Whitby, 1926.

**PHENACYL PALMITATE** $CH_3(CH_2)_{14}COO.CH_2COC_6H_5$ etc.

SOLUBILITY OF PHENACYL, BROMO PHENACYL AND CHLORO PHENACYL PALMITATES IN 95% ETHYL ALCOHOL.
(Hann, Reid and Jameson, 1930.)

| Palmitate | | | Formula | Gms. Palmitate per 100 cc 95% alcohol at: 20° | 25° |
|---|---|---|---|---|---|
| | Phenacyl | Palmitate | $CH_3(CH_2)_{14}COO.CH_2COC_6H_5$ | 0.5136 | 0.7880 |
| p Bromo | " | " | $CH_3(CH_2)_{14}COO.CH_2COC_6H_4Br$ | 0.0512 | 0.0684 |
| p Chloro | " | " | $CH_3(CH_2)_{14}COOCH_2COC_6H_4Cl$ | 0.0784 | 0.1020 |

**HEXADECYL IODIDE** $CH_3(CH_2)_{14}CH_2I$

Freezing-point data for mixtures of hexadecyl iodide and octa decyl iodide are given by Smith, 1932b.

**CETENE** (Hexadecane) $C_{16}H_{34}$.

Mutual Solubility of Cetene and Liquid Sulfur Dioxide.
(Seyer and Hugget, 1924.)

The cetene was prepared from spermaceti (cetyl palmitate) by destructive distillation at 300°, and purified by fractional vacuum distillation. The fraction having a melting-point close to that of cetene was redistilled 8 times. The bulb method was used for the determination of the freezing-points and the solubility.

| t° of complete miscibility. | Gms. $C_{16}H_{34}$ per 100 gms. mixture. | t° of complete miscibility. | Gms. $C_{16}H_{34}$ per 100 gms. mixture. |
|---|---|---|---|
| — 2.2 (f. pt.)..... | 100.00 | 42.5..... | 44.73 |
| + 9.5..... | 79.23 | 42.7 (crit. t.)..... | 35.13 |
| 20.5..... | 69.16 | 42.6..... | 17.40 |
| 28.1..... | 61.90 | 32.1..... | 6.64 |
| 34.8..... | 53.42 | 24.0..... | 3.97 |
| —38.1..... | 50.19 | 72.7 (m. pt. $SO_2$). | 0.00 |

Freezing-point data are given for mixtures of:

Hexadecane + Octadecane (Smith, 1932b.)
" + Heptadecane (Carey and Smith, 1933.)

**CETYL ALCOHOL** $C_{16}H_{33}OH$.

100 gms. methyl alcohol dissolve 96.9 gms. $C_{16}H_{33}OH$ at 23.9°. (Timofeiew, 1894.)
" ethyl " " 102.2 " " " " "
" " " " 410 " " " 37 "
" propyl " " 405 " " " 39 "

Solubility of Cetyl Alcohol in Liquid Sulfur Dioxide.
(Seyer and Ball, 1925.)

The bulb method was used. The temperatures were determined at which a small crystal of the alcohol just failed to dissolve and at which it just disappeared. The average of the two temperatures was taken as the temperature of solubility.

| t° of Solubility. | Gms. $C_{16}H_{33}OH$ In 100 gms. mixture. | t° of Solubility. | Gms. $C_{16}H_{33}OH$ per 100 gms mixture. |
|---|---|---|---|
| 48.0 (m. pt.).... | 100.0 | 23.5..... | 31.18 |
| 41.6..... | 95.85 | 23.8..... | 28.34 |
| 30.9..... | 69.00 | 22.7..... | 11.20 |
| 27.8..... | 66.27 | 22.7..... | 10.40 |
| 25.5..... | 57.46 | 22.2..... | 7.70 |
| 24.8..... | 46.39 | 5.3..... | 0.42 |
| 23.9..... | 34.87 | | |

Freezing-point lowering data for mixtures of *n* cetyl alcohol and diphenyl amine are given by Giua and Cherchi, 1919.

Freezing-point data are also given for mixtures of cetyl alcohol and

Apocholic acid(3)
Chlor acetic acid(2)
Cholic acid(4)
Desoxy cholic acid(3)
Diphenyl amine(3)
Hepta decyl alcohol(1)
Hyodesoxy cholic acid(4)
Octa decyl alcohol(1)(5)

(1) Carey and Smith, 1933; (2) Mamelli and Mannesier, 1913; (3) Rheinboldt, Flume and König, 1929; (4) Rheinboldt and Lauber, 1929; (5) Smith, 1931.

## CETYL PALMITATE and STEARATE.

SOLUBILITY OF EACH IN SEVERAL SOLVENTS. (Whitby, 1926.)

| Compound. | Formula. | Solvent. | t°. | Gms. empd. per 100 gms. solvent. |
|---|---|---|---|---|
| Cetyl palmitate.. | $C_{16}H_{33}C_{15}H_{31}COO$ | Ether (abs.) | 0 | 2.30 |
| » » | » | » » | 22 | 21.01 |
| » » ..... | » | Alcohol (abs.) | 22 | 0.0495 |
| » » ..... | » | Acetic acid (glacial) | 22 | 0.0633 |
| » stearate... | $C_{16}H_{33}C_{17}H_{35}COO$ | Ether (abs.) | 0 | 0.73 |
| » » .. | » | » » | 22 | 9.08 |
| » » .. | » | Alcohol (abs.) | 22 | 0.0594 |
| » » .. | » | Acetic acid (glacial) | 22 | 0.0388 |

**β NAPHTHYL BENZOATE** $C_6H_5COOC_{10}H_7$.

100 gms. 95% formic acid dissolve 0.25 gm. $C_6H_5COOC_{10}H_7$ at 18.6°. (Aschan, 1913.)

Freezing-point data for mixtures of β Naphthyl benzoate and salol are given by Angelletti, 1927.

**BETOL** (β-Naphthylsalicylate) $\beta C_7H_5O_3.C_{10}H_7$.

Freezing-point data including super solubility curves, are given for mixtures of betol and salol by Miers and Isaac, 1907.

**BENZYLIDENE NAPHTHYLAMINE** $C_{10}H_7N:CHC_6H_5$.

Freezing-point data for mixtures of the α and β forms are given by Pascal and Normand, 1913, and by Rheinboldt and Kirscheisen, 1926.

**α BENZYL NAPHTHALENE** (Methane 1-Naphthyl phenyl) $C_{10}H_7CH_2C_6H_5$.

Freezing-point data are given for:

α Benzyl naphthalene + picric acid (Pfeiffer and Angern, 1925.; Jefremow, 1918, 1919a.)
" " + styphnic acid (Puschin, 1925; Jefremow, 1918, 1919a.)

**DIBENZYL ACETONE** (Styrl ketone) $(C_6H_5CH:CH)_2CO$.

Freezing-point data are given for mixtures of:

Dibenzyl acetone + Acetic acid (Puschin and König, 1928.)
" " + Naphthols " " " "
" " + Resorcinol " " " "
" " + Phenyl acetic acid (Pfeiffer, 1924.)

**CINNAMYLIDENE ACETO PHENONE** $C_4H_4CO(C_6H_5)_2$.

Freezing-point data are given for mixtures of Cinnamylidene acetophenone and:

Acenaphthene(1)
Amino aceto phenone(3)
Azo benzene(1)
Bromo dinitro phenol(3)
Bromo nitro benzene(3)
Chloro nitro benzene(3)
Dinitro benzene(3)
Diphenyl amine(2)
β Naphthol ethyl ether(1)
Thymo quinone(3)
Trinitro toluene(1)

(1) Giua, 1916; (2) Giua, 1917; (3) Giua, 1925.

**ETHOXY BENZAL ACETOPHENONE** $C_2H_2(COC_6H_5)(C_6H_4OC_2H_5)$.

Freezing-point data for mixtures of ethoxy benzal aceto phenone with 2,4,6-tri nitro phenol are given by Asahima, 1934.

**DIMETHYL AMINO BENZAL ACETO PHENONE** $(CH_3)_2NC_6H_4CH{:}CHCOC_6H_5$.

Freezing-point data for mixtures of dimethyl amino benzal aceto phenone and naphthol are given by Pfeiffer, Goebel and Angern, 1925.

**EUGENOL BENZOATE** $C_6H_3(1)(CH_2.CH{:}CH_2)(3)OCH_3(4)OC_7H_5O$.
Freezing-points of mixtures of eugenol benzoate and isoeugenol benzoate are given by Mc Kie, 1921.

**APO MORPHINE** $C_{17}H_{17}NO_2$.

100cc $H_2O$ dissolve 0.12 gm. $C_{17}H_{17}NO_2$ at 15°. (Kolthoff, 1925.)
100cc Olive Oil dissolve 4.5 gm. $C_{17}H_{17}NO_2$ at 25°. (Walton, 1935.)

**APOMORPHINE HYDROCHLORIDE** $C_{17}H_{17}NO_2.HCl$.

100 gms. water dissolve 1.7 gms. salt at 15° and 2 gms. at 25°.
100 gms. 90% alcohol dissolve 2 gms. salt at 25°.

(Dott, 1906; Squires and Caines, 1905.)

$\alpha\alpha'$ Diphenyl **PIPERIDINES** $C_{17}H_{19}N$.

SOLUBILITIES OF THE ACID SALTS OF $\alpha\alpha'$ DIPHENYL PIPERIDINE AND OF ISO $\alpha\alpha'$ DIPHENYL PIPERIDINE IN WATER AT 25°.
(Scholtz, 1901.)

| Piperidine Base. | Gms. per 100 Gms. Sat. Solution: | | | |
|---|---|---|---|---|
| | HCl Salt. | HBr Salt. | HI Salt. | $H_2SO_4$ Salt. |
| $\alpha, \alpha'$ Diphenyl Piperidine, m. pt. 71° | 0.85 | 0.90 | 0.12 | 6.31 |
| Iso $\alpha, \alpha'$ Diphenyl Piperidine, liquid | 3.02 | 1 | 0.72 | easily soluble |

**PIPERINE** $C_{17}H_{19}NO_3$. (See also under Pilocarpine, page 690.)
SOLUBILITY IN SEVERAL SOLVENTS.

| Solvent. | t°. | Gms. $C_{17}H_{19}NO_3$ per 100 Gms. Solvent. | Authority. |
|---|---|---|---|
| Water | 20–25 | 0.01 | (Dehn, 1917.) |
| Ethyl Alcohol | 9.5 | 2.9 | (Timofeiew, 1894.) |
| Methyl " | 9.5 | 4.4 | " |
| Propyl " | 9.5 | 2.94 | " |
| Trichlor Ethylene | 15 | 9.83 | (Wester and Bruins, 1914.) |
| Pyridine | 20–25 | 22.46 | (Dehn, 1917.) |
| Aq. 50% Pyridine | 20–25 | 11.39 | " |

1000 cc. sat. solution of piperine in water contain $1.4.10^{-3}$ gm. mol. or 0.400 gm. $C_{17}H_{19}NO_3$ at 18°.
(Kolthoff, 1925.)

100 gms. abs. alcohol dissolve 6.66 gms. piperine at 20-25°.
" Quinoline " 13.66 " "
" Equi. mol. mixture of alcohol and quinoline dissolve 18.81 gms. piperine at 20-25°.
(Pucher and Dehn, 1921.)

**MORPHINE** $C_{17}H_{19}NO_3.H_2O$.

### Solubility of Morphine in Water at 18°.

A detailed discussion and calculation of the dissociation constants of morphine as a base and as an acid is given by Kolthoff, 1925. This author also reports a series of determinations of the solubility of morphine in buffer mixtures composed of 0.2 mol. $Na_2CO_3$ and 0.2 mol. $NaHCO_3$. A minimum solubility of $5.6.10^{-4}$ mols or 0.165 gm. morphine per liter was found at $p_H$ 9.1. This is in good agreement with the value of Maus, which is $4.7.10^{-4}$ mol. or 0.143 gm. per liter. The result found by Heiduschka and Faul (1917) for water of conductivity of $2.10^{-6}$ sec./ohms is $6.1.10^{-4}$ or 0.181 gm. morphine per liter at 18°. As a mean Kolthoff chooses $5.10^{-4}$ mol. or 0.147 gm. morphine per liter at 18°.

1000 gms. $H_2O$ sat. with finely powdered morphine base by constant shaking for 2 to 3 weeks at 20° contain 0.149 gm. $C_{17}H_{19}NO_3$ as determined by titration with 0.01 n HCl using methyl red as indicator.

(Baggesgaard-Rasmussen and Reimers, 1935.)

### Solubility of Morphine in Water at Different Hydrogen Ion Concentrations at 20°.

(Baggesgaard-Rasmussen and Reimers, 1935.)

An excess of finely powdered morphine base was shaken for periods of 8 to 10 days with a series of buffer solutions of $P_H$ varying from 6.7 to 10.3. The morphine in the saturated filtered solution thus obtained was calculated from nitrogen determinations made by the Kjeldahl method.

| Buffer Mixture | $P_H$ of the sat. solution | Gm. Mol. Morphine per liter | Buffer Mixture | $P_H$ of the sat. solution | Gm. Mol. Morphine per liter |
|---|---|---|---|---|---|
| Phosphate | 6.66 | 0.01388 | Borate + HCl | 8.38 | 0.00075 |
| " | 6.72 | 0.01154 | " " | 8.53 | 0.00068 |
| " | 6.80 | 0.01001 | " " | 8.78 | 0.00053 |
| " | 6.90 | 0.00852 | " " | 9.00 | 0.00051 |
| " | 7.08 | 0.00537 | " " | 9.10 | 0.00056 |
| " | 7.12 | 0.00459 | Borate + NaOH | 9.18 | 0.00057 |
| " | 7.26 | 0.00332 | " " | 9.42 | 0.00069 |
| " | 7.51 | 0.00219 | " " | 9.62 | 0.00098 |
| " | 8.00 | 0.00109 | " " | 9.86 | 0.00138 |
| Borate + HCl | 8.15 | 0.00088 | " " | 10.27 | 0.00200 |

### Solubility of Morphine in Aqueous Solutions of Salts and Bases at Room Temperature, Shaken Eight Days.

(Dieterich, 1890.)

| Aq. Salt or Base. | In N/10 Salt or Base. Grams per Liter. Salt or Base. | Morphine. | In N/1 Salt or Base. Grams per Liter. Salt or Base. | Morphine. |
|---|---|---|---|---|
| $NH_4OH$ | 3.51 | 0.20 | 35.08 | 0.505 |
| $(NH_4)_2CO_3$ | 4.80 | 0.031 | 48.03 | 0.040 |
| KOH | 4.62 | 2.78 | 46.16 | ... |
| $K_2CO_3$ | 6.92 | 0.20 | 69.15 | 0.379 |
| $KHCO_3$ | 10.02 | 0.024 | 100.16 | 0.040 |
| NaOH | 4.00 | 3.33 | 40.05 | ... |
| $Na_2CO_3$ | 5.30 | 0.09 | 53.03 | 0.14 |
| $NaHCO_3$ | 8.41 | 0.032 | 84.06 | 0.044 |
| $Ca(OH)_2$ (sat.) | ... | 1.00 (25°) | ... | ... |

## Solubility of Morphine in Aqueous Solutions of Ammonia.

(Heiduschka and Faul, 1917.)

An excess of finely ground crystalline morphine was constantly agitated with the ammonia solutions in a thermostat. The saturated solutions were analyzed by evaporating and weighing the residues dried at 100°.

| Normality of aq. ammonia. | t°. | Gms. $C_{17}H_{19}NO_3.H_2O$ per 100 cc. sat. sol. | Normality af aq. ammonia. | t° | Gms. $C_{17}H_{19}NO_3.H_2O$ per 100 cc. sat. sol. |
|---|---|---|---|---|---|
| 0.1 | 18 | 0.0882 | 0.588 (= 1% $NH_3$) | 18 | 0.2480 |
| 0.1 | 25 | 0.0974 | 0.588 (= 1% $NH_3$) | 25 | 0.2550 |
| 0.2 | 18 | 0.1226 | 2.941 (= 5% $NH_3$) | 18 | 0.4316 |
| 0.2 | 25 | 0.1240 | 2.941 (= 5% $NH_3$) | 25 | 0.4406 |
| 1.0 | 18 | 0.3086 | 5.88 (=10% $NH_3$) | 18 | 0.6380 |
| 1.0 | 25 | 0.3242 | 5.88 (=10% $NH_3$) | 25 | 0.7100 |

## Solubility of Morphine in Aqueous Solutions of Methyl Alcohol at 20°.

(Baggesgaard-Rasmussen and Reimers, 1935.)

The dissolved morphine was titrated directly in the alcoholic solution using methyl red as indicator and as soon as the color changed to reddish yellow 4 to 5 volumes of water were added and the titrations continued until a red end point was reached.

| Wt. % $CH_3OH$ in aq. solvent | Gms. $C_{17}H_{19}NO_3$ per 100 gms. sat. solution | Gms. $C_{17}H_{19}NO_3$ per 100 gms. solvent |
|---|---|---|
| 26 | 0.0388 | 0.0388 |
| 50 | 0.135 | 0.135 |
| 75 | 0.373 | 0.375 |
| 90 | 0.710 | 0.715 |
| 100 (approx.) | 5.382 | 5.688 |

## Solubility of Morphine in Aqueous Solutions of Ethyl Alcohol at 20°.

(Baggesgaard-Rasmussen and Reimers, 1935.)

| Wt. % $C_2H_5OH$ in aq. solvent | Gms. $C_{17}H_{19}NO_3$ per 100 gms. sat. sol. | Gms. $C_{17}H_{19}NO_3$ per 100 gms. solvent | Wt. % $C_2H_5OH$ in aq. solvent | Gms. $C_{17}H_{19}NO_3$ per 100 gms. sat. sol. | Gms. $C_{17}H_{19}NO_3$ per 100 gms. solvent |
|---|---|---|---|---|---|
| 5 | 0.0200 | 0.0200 | 60 | 0.243 | 0.243 |
| 10 | 0.0214 | 0.0214 | 70 | 0.294 | 0.293 |
| 20 | 0.0325 | 0.0325 | 80 | 0.326 | 0.327 |
| 30 | 0.0596 | 0.0596 | 90 | 0.342 | 0.343 |
| 40 | 0.114 | 0.114 | 95 | 0.411 | 0.413 |
| 50 | 0.178 | 0.178 | 99.1 | 0.995 | 1.094 |
| | | | 100 | 2.549 | 2.616 |

## Solubility of Morphine in Several Solvents.

(U. S. P.; Müller, W., 1903.)

| Solvent. | Gms. Morphine per 100 Gms. Solution. At 18°–22°. | At 25°. | At 80°. |
|---|---|---|---|
| Water | 0.0283 | 0.030 | 0.0961 |
| Alcohol | ... | 0.600 | 1.31 (60°) |
| Ether | 0.0131 | 0.0224 | ... |
| Ether sat. with $H_2O$ | 0.0094 | ... | ... |
| $H_2O$ sat. with Ether | 0.0447 | ... | ... |
| Benzene | 0.0625 | ... | ... |
| Water | 0.0254 (20°) (Winterstein, 1909.) | | |
| Chloroform | 0.0504 (20°) " | | |
| Water | 0.0288 (15°) (Guerin, 1913.) | | |
| Acetone | 0.128 (15°) " | | |
| Aq. 50 Vol. % Acetone | 0.132 (15°) " | | |
| Water | 0.0217 (20°) (Zalai, 1910.) | | |
| Water | 0.0192 (20°) (Guild, 1907.) | | |

| Solvent. | Gms. Morphine per 100 Gms. Solution. At 18°–22°. | At 25°. |
|---|---|---|
| Chloroform | 0.0655 | 0.0555 |
| Amyl Alcohol | ... | 0.8810 |
| Ethyl Acetate | 0.1861 | 0.1905 |
| Petroleum Ether | 0.0854 | ... |
| Carbon Tetrachloride | 0.0156 | 0.032 (17°) |
| Glycerol | 0.45 (15.5°) | ... |
| $CCl_4$ | 0.025 (20°) (Gori, 1913.) | |
| Aniline | 6.1 (20°) (Scholtz, 1912.) | |
| Pyridine | 16 (20°) " | |
| Piperidine | 39.8 (20°) " | |
| Diethylamine | 7.41 (20°) " | |
| 50% Aq. Glycerol + 3% $H_3BO_3$ | 5.2 (r. temp.) (Baroni and Barlinetto, 1911.) | |

## Solubility of Morphine at 20° in Mixtures of Chloroform and:

(Baggesgaard-Rasmussen and Reimers, 1935.)

### Ethyl Alcohol

| Wt. % $C_2H_5OH$(1) in solvent mixture | d15/15 of sat. sol. | Gms. $C_{17}H_{19}O_3$ per 100 gms. sat. sol. |
|---|---|---|
| 0.0(=$CHCl_3$)(2) | 1.590 | 0.021 |
| 10 | 1.367 | 1.004 |
| 20 | 1.268 | 1.925 |
| 30 | 1.183 | 2.286 |
| 35 | 1.146 | 2.288 |
| 40 | 1.110 | 2.267 |
| 50 | 1.040 | 2.055 |
| 60 | 0.981 | 1.762 |
| 80 | 0.878 | 1.337 |
| 100 | 0.7957 | 1.175 |
| 25(3) | 1.226 | 1.898 |
| 50 | 1.042 | 1.763 |
| 75 | 0.902 | 1.221 |
| 100 | 0.797 | 1.004 |

### Iso Propyl Alcohol

| Wt. % $CH_3CHOHCH_3$ in solvent mixture | d 15/15 of sat. sol. | Gms. $C_{17}H_{19}O_3$ per 100 gms. sat. sol. |
|---|---|---|
| 0.0(=$CHCl_3$)(4) | 1.497 | 0.011 |
| 15 | 1.317 | 0.386 |
| 25 | 1.213 | 0.562 |
| 35 | 1.146 | 0.650 |
| 50 | 1.043 | 0.575 |
| 75 | 0.915 | 0.372 |
| 100 | 0.800 | 0.207 |

(1) 99.35 Wt. %; (2) Ordinary commercia
(3) 99.1 Wt. % $C_2H_5OH$ was used.

100cc Olive oil dissolve 0.005 gms. morphine at 25°. (Walton, 1935.)

### Solubility of Morphine in Several Solvents at 25°.

(Schaefer, 1913.)

| Solvent. | Gms. $C_{17}H_{19}NO_3.H_2O$ per 100 cc. Solvent. | Solvent. | Gms. $C_{17}H_{19}NO_3.H_2O$ per 100 cc. Solvent. |
|---|---|---|---|
| Ethyl Alcohol | 0.388 | 1 Vol. $C_2H_5OH$ + 4 Vols. $CHCl_3$ | 0.66 |
| Methyl Alcohol | 6.66 | " + 4 Vols. $C_6H_6$ | 0.2 |
| Chloroform | 0.04 | 1 Vol. $CH_3OH$ + 4 Vols. $CHCl_3$ | 4.54 |
| Benzene | insol. | " + 4 Vols. $C_6H_6$ | 2.5 |

### Solubility of Morphine in Ethyl Ether at 5.5°.

(Marchionneschi, 1907.)

| Solvent. | Gms. Morphine per 100 Gms. Sat. Sol. | Solid Phase. |
|---|---|---|
| Washed and Distilled Ether | 0.049 | $C_{17}H_{19}NO_3.H_2O$ |
| Ether Purified by Distillation over Na | 0.263 | " |
| " " " " | 0.56 | $C_{17}H_{19}NO_3$ |

**MORPHINE ACETATE** $CH_3COOH.C_{17}H_{19}NO_3.3H_2O$, Morphine Hydrochloride $HCl.C_{17}H_{19}NO_3.3H_2O$, Morphine Sulphate $H_2SO_4.(C_{17}H_{19}NO_3)_2.5H_2O$, and Apo Morphine Hydrochloride $HCl.C_{17}H_{17}NO_2$.

### Solubility in Several Solvents.

(U. S. P.)

| Solvent. | Grams per 100 Grams of Solvent. | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Acetate. | | Hydrochloride. | | Sulphate. | | Apo M. Hydrochloride. | |
| | 25°. | 80°. | 25°. | 80°. | 25°. | 80°. | 25°. | 80°. |
| Water | 44.9 | 50.0 | 5.81 | 200.0 | 6.53 | 166.6 | 2.53 | 6.25 |
| Alcohol | 4.6 | 40.0* | 2.4 | 2.8* | 0.22 | 0.53* | 2.62 | 3.33 |
| Chloroform | 0.21 | ... | ... | ... | ... | ... | 0.026 | ... |
| Ether | ... | ... | ... | ... | ... | ... | 0.053 | ... |
| Glycerine | 19.2 | ... | 20.0† | ... | ... | ... | ... | ... |

* 60°. † 15.5°.

100 gms. $H_2O$ dissolve 1.69 gms. apo morphine hydrocloride at 15.5°, and 2.04 gms. at 25°.

100 gms. 90% alcohol dissolve 1.96 gms. apo morphine hydrochloride at about 15.5°.

(Dott, 1906.)

100 gms. $H_2O$ dissolve 4.17 gms. morphine hydrated sulfate $.5H_2O$ at 15°.

(Power, 1882.)

## MORPHINE SALTS

### Solubility in Water and in 90% Alcohol at Ord. Temp.

(Squire and Caines, 1905.)

| Morphine Salt. | Gms. Salt per 100 cc. | |
|---|---|---|
| | $H_2O$. | 90% Alcohol. |
| Morphine Acetate | ... | 1 |
| " Hydrochloride | ... | 2 |
| " Sulfate | ... | 0.143 |
| " Tartrate | 10 | 0.172 |

| Morphine Salt. | Gms. Salt per 100 cc. | |
|---|---|---|
| | $H_2O$. | 90% Alcohol. |
| Diacetyl Morphine (Heroine) | 0.11 | 2.5 |
| " " HCl | 50 | 9.1 |
| Ethyl Morphine HCl (Dionin) | 14.3 | 20 |

100 gms. 4% $HClO_4$ solution dissolve 0.44 gm. morphine perchlorate at 15°.

(Hofmann, Roth, Höbald and Metzler, 1910.)

Solubility of Morphine Salts in Several Solvents at 25°.
(Schaeffer, 1913.)

| Solvent. | Gms. of Each Salt Separately per 100 cc. of Each Solvent. | | | | |
|---|---|---|---|---|---|
| | Morphine Hydrochloride. | Morphine Sulfate. | Diacetyl Morphine. | Diacetyl Morphine HCl. | Ethyl Morphine HCl. |
| 95% Ethyl Alcohol | 0.606 | 0.2 | 3 | 9.1 | 4 |
| 85% Ethyl Alcohol | 1.2 | 0.4 | ... | ... | ... |
| 80% Ethyl Alcohol | 2 | 0.77 | ... | ... | ... |
| Methyl Alcohol | ... | ... | 4 | 11.1 | 66.6 |
| Chloroform | Insol. | Insol. | 66.6 | 33.3 | 0.526 |
| Benzene | Insol. | Insol. | 12.5 | Insol. | Insol. |
| 1 Vol. $C_2H_5OH$ + 4 Vols. $CHCl_3$ | 0.18 | 0.0164 | 66.6 | 4.5 | 5 |
| " + 4 Vols. $C_6H_6$ | 0.089 | 0.0133 | 25 | 0.71 | 1.14 |
| 1 Vol. $CH_3OH$ + 4 Vols. $CHCl_3$ | ... | 0.22 | 66.6 | 20 | 20 |
| " + 4 Vols. $C_6H_6$ | 0.253 | 0.066 | 25 | 6.6 | 8.33 |

**MORPHINE HELIANTHATE** $C_{17}H_{19}NO_3.C_{14}H_{18}N_3SO_3$.

1000 cc. water dissolve 0.4 gm. morphine helianthate at 20–25°.
(Stark and Dehn, 1918.)

**MORPHINE PICRATE** $C_{17}H_{19}NO.OH.C_6H_2(NO_2)_3$.

Solubility of Morphine Picrate in Several Solvents at 20°.

The « saturated » solutions containing precipitated crystals were allowed to stand in an incubator at 20° for two days and then analyzed by evaporation and weighing the residues dried at 100°. (Maplethorpe and Evers, 1925.)

| Solvent. | Gms. Picrate per 100 gms. sat. sol. |
|---|---|
| Water | 0.22 |
| Abs. alcohol | 0.14 |
| Acetone | 13.86 |

**MICHLER'S KETONE** (Tetramethyl-$p_2$-diamidobenzophenone) $CO[C_6H_4(4)\text{-}N(CH_3)_2]_2$.

100 gms. $H_2O$ dissolve 0.04 gm. of ketone at 20–25°. (Dehn, 1917)
" pyridine " 9.92 " " " " "
" aq. 50% pyridine " 3.59 " " " " "

100 gms absolute alcohol dissolve 0 63 gm. Michler's Ketone at 20°-25°
" quinoline " 9.72 " " " "
" equi. mol. mixture of alcohol and quinoline dissolve 6.86 gms. Michler's Ketone at 20°-25°. (Pucher and Dehn, 1921.)

Freezing-point data are given for mixtures of Michler's Ketone and:

Dimethoxy stilbene(1)
Menthol(1)
Naphthoic acid(1)
Naphthols(1)
Naphthylamine(1)
Neroline(1)
Resorcinol(1)
Skatol(1)
Veronal(Barbital)(2)

(1) Pfeiffer, 1924; (2) Pfeiffer and Angern, 1926.

Results for mixtures of Dimethyl amino benzo phenone and β naphthol are given by Pfeiffer, 1924.

$C_{17}H_{20}O_1$

## DIETHYL DIPHENYL UREA $(C_2H_5\ N\ C_6H_5)_2CO$.

### Solubility of Diethyl Diphenyl Urea in Water and in Aqueous Ethyl Alcohol.

(Desvergnes, 1928.)

| Solvent | | Gms. $(C_2H_5\ N\ C_6H_5)_2CO$ per 100 gms. solvent at: | | |
|---|---|---|---|---|
| Vol. % $C_2H_5OH$ | $d_{15}$ of solvent | 0° | 20° | 50° |
| 0.0(= $H_2O$) | — | 0.003 | 0.008 | 0.012(0.3 at 85°) |
| 29.9 | 0.9656 | trace | 0.027 | — |
| 37.3 | 0.9556 | 0.041 | 0.193 | — |
| 52.4 | 0.9310 | 0.424 | 1.690 | — |
| 68.6 | 0.8939 | 3.225 | 9.857 | — |
| 77.1 | 0.8724 | 6.537 | 21.126 | — |
| 87.1 | 0.8430 | 12.979 | 43.080 | 403.28 |
| 92.0 | 0.8272 | 16.646 | 55.581 | 428.33 |
| 95.2 | 0.8145 | 24.262 | 65.359 | 462.66 |
| 100.0 | 0.7944 | 28.352 | 72.673 | 545.26 |

At a temperature of 50° and concentrations of alcohol below 77 vol. percent two liquid layers are formed. Results for several of these are given.

### Solubility of Diethyl Diphenyl Urea in Several Solvents.

(Desvergnes, 1928.)

| Solvent | Gms. $(C_2H_5\ N\ C_6H_5)_2CO$ per 100 gms. solvent at | | | Solvent | Gms. $(C_2H_5\ N\ C_6H_5)_2CO$ per 100 gms. solvent at | | |
|---|---|---|---|---|---|---|---|
| | 0° | 20° | 50° | | 0° | 20° | 50° |
| $CH_3COOC_2H_5$ | 36.92 | 76.84 | — | $(C_2H_5)_2O$ | 31.40 | 71.37 | — |
| $(CH_3)_2CO$ | 34.11 | 63.59 | — | $C_5H_5N$ | 52.81 | 97.35 | 444.66 |
| $C_2H_5OH$ | 28.35 | 72.67 | 515.26 | $CS_2$ | 28.32 | 74.07 | — |
| $CH_3OH$ | 25.20 | 101.75 | 799.49 | $CCl_4$ | 27.67 | 50.23 | 185.12 |
| $C_6H_6$ | 61.03 | 101.55 | 414.93 | $C_6H_5CH_3$ | 45.98 | 72.90 | 298.28 |
| $CHCl_3$ | 74.90 | 146.18 | — | m $C_6H_4(CH_3)_2$ | 26.47 | 58.14 | 450.00 |

Freezing-point data are given for mixtures of Diethyl Diphenyl Urea and:

Bromo dinitro phenol(1)
Dinitro toluene(1)
Diphenyl amine(1)
Nitro mannitol(3)
Nitro penta erythritol(3)
Nitro toluene(1)
Phenol(2)
Tri methylene nitramine(4)
Tri nitro phenol(1)
Tri nitro toluene(1)

(1) Giua and Guastalla, 1933; (2) Medard, 1930-1; (3) Urbanski, 1933; (4) Urbanski and Rabek-Gawronska, 1934.

## TETRA METHYL DIAMINO BENZO PHENONE $N(CH_3)_2C_6H_4COC_6H_4N(CH_3)_2$.

Freezing-point data are given by Pfeiffer, Goebel and Angern, 1925 for mixtures of tetra methyl diamino benzo phenone and each of the following compounds: acenáphthene, benzidine, menthol, naphthol, naphthylamine, naphthoic acid, neroline, nitraniline, oxybenzoic acid, phenyl acetic acid, resorcinol and skatol. Results for mixtures with veronal are given by Pfeiffer and Angern, 1926.

## BENZOYL CAMPHOR $C_{17}H_{20}O_2$.

Solubility of the Enolic and Ketonic Forms in Several Solvents at 17°
(MacConkey, 1929.)

| Solvent | Gms. $C_{17}H_{20}O_2$ per 100 gms. sat. sol. | |
|---|---|---|
| | Enolic form | Ketonic form |
| Ethyl alcohol | 3.37 | 2.95 |
| Acetone | 19.0 | 19.3 |
| Benzene | 37.3 | 16.9 |

Data, in the form of diagrams, are given by Vixseboxse, 1921, for the freezing-points and for the solubilities of the enolic and ketonic forms of mono benzoyl camphor in ether (at 15°) acetone, alcohol, toluene and acetic acid, at 17°.

Solubility data have been used by Dimroth and Mason (1913) for determining the transition of the tautomeric forms into each other. Results are given for the solubility of each form in ether, acetone, ethylacetate, ethyl alcohol and methyl alcohol.

One liter benzene dissolves 256 gms. *enol* benzoylcamphor at 5°, by freezing-point method. (Sidgwick, 1915.)

## COCAINE $C_{17}H_{21}NO_4$ (Benzoyl ecgonine methyl ester).

Solubility in Water. (Kolthoff, 1925.)

By means of colorimetric determinations of the $p_H$ of mixtures of 5 cc. of 0.05 molecular cocaine hydrochloride and 0.01 normal sodium hydroxide solutions the dissociation constant was calculated to be $K = 2.6.10^{-6}$. For the determination of the solubility product (L), 2 cc. portions of 0.05 molecular cocaine hydrochloride were mixed in tubes of resistance glass with different amounts of 0.01 normal Na OH, shaken and allowed to stand. With 2.0 cc. of 0.01 normal Na OH crystals separated after 4 hours. From this experiment the solubility product was calculated to be $L = 1.10^{-8}$ at 15°. The concentration of the undissociated alkaloid in the saturated solution is derived thus.

$$[\text{Cocaine OH}]\,\text{sat.} = \frac{L}{K} = \frac{1.10^{-8}}{2.6.10^{-6}} = 4.10^{-3}\ \text{mol.}$$

"The concentration of the dissociated part is $10^{-4}$ mol., so that the total solubility of cocaine in water is $4.10^{-3}$ mol."

## Tropa**COCAINE** $C_8H_{14}NO.CO.C_6H_5$.

Solubility in Water. (Kolthoff, 1925.)

The dissociation constant was calculated from the colorimetrically determined $p_H$ curve to be $K = 1.9.10^{-5}$. For the solubility product it was found that 5.0 cc. of a 0.1 molecular tropacocaine hydrochloride solution + 2.0 cc. of 0.055 normal Na OH gave a just perceptible precipitate of tropacocaine after standing a day. The $p_H$ of the solution was 8.4 corresponding to a $p_{OH} = 5.8$ and a $[OH] = 16.10^{-6}$. From the composition of the solution and the hydroxyl ion concentration the solubility product was calculated to be $8.10^{-8}$. From this and the dissociation constant it was calculated that a saturated solution of tropacocaine in water at 15° has a concentration of $4.3.10^{-3}$ mol.

SOLUBILITY OF COCAINE IN SEVERAL SOLVENTS.

| Solvent. | t°. | Gms. $C_{17}H_{21}NO_4$ per 100 Gms. Solvent. | Authority. |
|---|---|---|---|
| Water | 20 | 0.028 | (Zalai, 1910.) |
| " | ±20 | 0.140 | (Baroni and Barlinetti, 1911.) |
| " | 25 | 0.17 | (U. S. P.) |
| " | 80 | 0.38 | " |
| 3 Gms. $H_3BO_3$ in Aq. 50% Glycerol | ±20 | 8 | (Baroni and Barlinetti, 1911.) |
| Alcohol (92.5 Wt. %) | 25 | 20 | (U. S. P.) |
| Ether | 25 | 26.3 | " |
| " | 18–22 | 11.6 | (Müller, 1903.) |
| Ether sat. with $H_2O$ | 18–22 | 34 | " |
| Water sat. with Ether | 18–22 | 0.254 | " |
| Aniline | 20 | 76 | (Scholtz, 1912.) |
| Carbon Tetrachloride | 20 | 31.94 | (Gori, 1913.) |
| Chloroform | 18–22 | 100+ | (Müller, 1903.) |
| Benzene | 18–22 | 100 | " |
| Ethyl Acetate | 18–22 | 59 | " |
| Petroleum Ether | 18–22 | 2.37 | " |
| Pyridine | 20–25 | 80+ | (Dehn, 1917; Scholtz, 1912.) |
| Piperidine | 20 | 56 | (Scholtz, 1912.) |
| Diethylamine | 20 | 36 | " |
| Sesame Oil | 20 | 4.34* | (Zalai, 1910.) |
| Olive Oil | 25 | 8.3 | (U. S. P.) |
| Oil of Turpentine | 25 | 7.1 | " |

* Per 100 cc.

100 cc of Olive oil dissolve 4.5 gms. cocaine at 25°. (Walton, 1935.)

**COCAINE HYDROCHLORIDE** $C_{17}H_{21}NO_4.HCl$.

100 gms. $H_2O$ dissolve 250 gms. of the salt at 25° and 1000 gms. at 80°. (U. S. P.)
100 gms. 92.3% alcohol dissolve 38 gms. salt at 25° and 71 gms. at 60°. (U. S. P.)
100 gms. chloroform dissolve 5.4 gms. salt at 25°. (U. S. P.)
100 gms. glycerol dissolve 25 gms. salt at 15°. (B. P.)

**COCAINE PERCHLORATE** $C_{17}H_{21}NO_4.HClO_4$.

100 gms. $H_2O$ (containing 8% free $HClO_4$) dissolve 0.26 gm. perchlorate at 6°. (Hofmann, Roth, Höbold and Metzler, 1910.)

**HYOSCINE** (Scopolamine) **HYDROBROMIDE,** etc.

SOLUBILITY IN SEVERAL SOLVENTS AT 25°. (U. S. P. VIII.)

| Solvent. | Grams per 100 Grams Solvent. Hyoscine Hydrobromide $C_{17}H_{21}NO_4HBr.3H_2O$. | Hyoscyamine Hydrobromide $C_{17}H_{23}NO_3.HBr$. | Hyoscyamine Sulfate $(C_{17}H_{23}NO_3)_2.H_2SO_4$ |
|---|---|---|---|
| Water | 66.6 | very soluble | very soluble |
| Alcohol | 6.2 | 50 | 15.6 |
| Ether | ... | 0.062 | 0.04 |
| Chloroform | 0.133 | 40 | 0.043 |

TETRA METHYL DIAMINO BENZHYDROL $C_6H_5C_6(CH_3)_4(NH_2)_2CHOH$.

Freezing-point data for mixtures of tetra methyl diamino benzhydrol and benzene are given by Schmidlin and Lang, 1912.

## ATROPINE $C_{17}H_{23}NO_3$.

SOLUBILITY IN WATER AT 18°. (Kolthoff, 1925.)

The aqueous solution of atropine is very unstable. The compound saponifies to tropin and tropaic acid. The solubility diminishes greatly on long shaking. The author obtained constant values after 1 to 2 hours shaking. The saturated solution was filtered and 25 cc. titrated with 0.01 *n* HCl using methyl red as indicator. The results correspond to a solubility of $5.5.10^{-3}$ mol. or 1.59 gm. per liter. The dissociation constant was determined by colorimetric $p_H$ estimations in 5 cc. portions of a 0.01 mol. $C_{17}H_{23}NO_3.HCl$ solution to which increasing amounts of 0.01 *n* NaOH were added. The calculated constant $K = 4.5.10^{-6}$.

## ATROPINE $C_{17}H_{23}NO_3$.

SOLUBILITY OF ATROPINE, $C_{17}H_{23}NO_3$, AND OF ATROPINE SULFATE, $(C_{17}H_{23}NO_3)_2.SO_2(OH)_2$, IN WATER AND OTHER SOLVENTS.
(U. S. P.; Müller, 1903.)

| Solvent. | t°. | Grams Atropine per 100 Grams. Solution | Grams Atropine per 100 Grams. Solvent. (U. S. P.) | Grams Atropine Sulfate per 100 Grms Solvent. (U. S. P.) |
|---|---|---|---|---|
| Water | 25 | 1.782 (20°) | 0.222 (0.13*) | 263.1 |
| Water | 80 | ... | 1.15 | 454.5 |
| Alcohol | 25 | ... | 68.44 | 27 |
| Alcohol | 60 | ... | 111.11 | 52.6 |
| Ether | 25 | 2.21 (20°) | 6.02 | 0.047 |
| Chloroform | 25 | 68.03 (20°) | 64.10 | 0.161 |
| Benzene | 20 | 3.99 | ... | ... |
| Carbon Tetrachloride | 20 | 0.661 | 1.136† (1.76‡) | ... |
| Ethyl Acetate | 20 | 3.88 | ... | ... |
| Petroleum Ether | 20 | 0.83 | ... | ... |
| Glycerol | 15 | ... | 3 | 33 |
| Aniline | 20 | ... | 34§ | ... |
| Diethylamine | 20 | ... | 67§ | ... |
| Pyridine | 20 | ... | 73§ | ... |
| Piperidine | 20 | ... | 114§ | ... |
| 50% Aq. Glycerol + 3% $H_3BO_3$ | .. | 10¶ | ... | ... |
| Oil of Sesame | 20 | ... | 0.25* | ... |

* Zalai, 1910. † At 17°, Schnidelmeiser, 1901. ‡ Gori, 1913. § Scholtz, 1912. ¶ Baroni and Borlinetto, 1911.

100 cc of Olive Oil dissolve 1.4 gm. atropine at 25°. (Walton, 1935.)

DISTRIBUTION OF ATROPINE BETWEEN WATER AND CHLOROFORM AT 25°.
(Seidell, 1910*a*.)

| Gms. Atropine Added per 15 cc. $H_2O$+15 cc. $CHCl_3$. | Gms. Atropine Recovered per 15 cc. Aqueous Layer (*a*). | Chloroform Layer (*b*). | $\frac{b}{a}$. |
|---|---|---|---|
| 0.005 | 0.0010 | 0.0057 | 5.7 |
| 0.025 | 0.0021 | 0.0256 | 12.2 |
| 0.125 | 0.0049 | 0.1246 | 25.4 |
| 0.625 | 0.0160 | 0.6267 | 39.1 |

## ATROPINE METHYLBROMIDE $C_{17}H_{23}NO_3.CH_3Br$.

100 gms. water dissolve 100 gms. of the salt at room temp. (Squires and Caines, 1905.)
100 cc. 90% alcohol dissolve 10 gms. of the salt at room temp. " "

**HYOSCYAMINE** $C_{17}H_{23}NO_3$.

SOLUBILITY IN SEVERAL SOLVENTS AT 18°–22°.
(Müller, 1903.)

| Solvent. | Gms. $C_{17}H_{21}NO_3$ per 100 Gms. Solution. | Solvent. | Gms. $C_{17}H_{21}NO_3$ per 100 Gms. Solution. |
|---|---|---|---|
| Water | 0.355 | Chloroform | 100+ |
| Ether | 2.02 | Acetic Ether | 4.903 |
| Ether sat. with $H_2O$ | 3.913 | Petroleum Ether | 0.098 |
| Water sat. with Ether | 3.125 | Carbon Tetrachloride | 0.059 |
| Benzene | 0.769 | | |

Menthyl **MANDELATES.** $C_6H_5CH(OH)COOC_{10}H_{19}$.

SOLUBILITY IN ETHYL ALCOHOL.
(Findlay and Hickmans, 1909.)

| Solvent. | t°. | Gms. per 100 Gms. Solvent. L. | Gms. per 100 Gms. Solvent. D. | Solid Phase. | Solvent. | t°. | Gms. per 100 Gms. Solvent. L. | Gms. per 100 Gms. Solvent. D. | Solid Phase. |
|---|---|---|---|---|---|---|---|---|---|
| 80% Alcohol | 35 | ... | 1.08 | *D* | 80% Alcohol | 10 | ... | 0.287 | *D* |
| "* | 35 | 3.19 | ... | *L* | " | 10 | 0.595 | ... | *L* |
| " | 35 | 0.80 | 0.80 | *R* | " | 10 | 0.184 | 0.184 | *R* |
| " | 35 | 0.544 | 1.35 | *D*+*R* | " | 10 | 0.404 | 0.291 | *D*+*R* |
| " | 35 | 2.83 | 0.60 | *L*+*R* | " | 10 | 0.505 | 0.088 | *L*+*R* |
| " | 25 | ... | 0.595 | *D* | Abs. Alcohol | 0 | ... | 1.06 | *D* |
| " | 25 | 1.64 | ... | *L* | " | 0 | 1.93 | ... | *L* |
| " | 25 | 0.448 | 0.448 | *R* | " | 0 | 0.625 | 0.625 | *R* |
| " | 25 | 0.321 | 0.882 | *D*+*R* | " | 0 | 0.535 | 0.915 | *D*+*R* |
| " | 25 | 1.192 | 0.267 | *L*+*R* | " | 0 | 1.03 | 0.54 | *L*+*R* |

* $d_{25} = 0.8517$.

*D* = *l* menthyl *d* mandelate, $[\alpha]_D^{17.5} = -9.45°$ in alcohol.

*L* = *l* menthyl *l* mandelate $[\alpha]_D^{20} = -140.92°$ in alcohol.

*R* = *l* menthyl *r*-mandelate $[\alpha]_D^{11.3} = -75.03$ in alcohol.

**MARGARIC ACID** $CH_3(CH_2)_{15}COOH$.

Freezing-point data are given for mixtures of:

Margaric Acid + Palmitic acid (Smith, 1936; Shriner, Fulton and Burks, Jr.,
" " + Stearic acid " " " " " " "
" " + " + Palmitic acid (Shriner, Fulton and Burks, Jr., 1933.)

**HEPTA DECANE** $CH_3(CH_2)_{15}CH_3$.

Freezing-point data are given by Carey and Smith, 1933, for mixtures of hepta decane with hexaca decane and with octa decane.

**HEPTA DECANOL** (Heptadecyl alcohol) $CH_3(CH_2)_{16}OH$

Freezing-point data are given by Carey and Smith, 1933, for mixtures of hepta decanol with hexa decanol and with octa decanol.

**CHRYSENE** $C_{18}H_{12}$.

SOLUBILITY IN TOLUENE AND IN ABS. ALCOHOL.
(v. Becchi.)

100 gms. toluene dissolve 0.24 gm. $C_{18}H_{12}$ at 18°, and 5.39 gms. at 100°.
100 gms. abs. alcohol dissolve 0.097 gm. $C_{18}H_{12}$ at 16°, and 0.170 gm. at boiling point.

Freezing-point data are given by Pascal, 1921, for mixtures of chrysene with anthracene, with carbazole, with phenanthrene and with both carbazole and anthracene.

**TRIPHENYL ARSINE** $(C_6H_5)_3As$, etc.

Freezing-point data are given by Pascal, 1912, 1923, for mixtures of:

Triphenyl arsine + Triphenyl bismathine
" " + Triphenyl phosphine
" " + Triphenyl stilbine
" " oxide + Triphenyl phosphine oxide
" " " + Triphenyl stibine sulfide
" " " + Triphenyl arsine sulfide
" " " + Triphenyl amine
" " sulfide + Triphenyl phosphine sulfide
" " " + Triphenyl phosphine oxide
" " " + Triphenyl stibine sulfide
" " " + Triphenyl arsine oxide
" bismuthine + Triphenyl phosphine
" " + Triphenyl arsine
" phosphine + Triphenyl amine
" " + Triphenyl arsine
" " + Triphenyl bismuthine
" " oxide + Triphenyl phosphine sulfide
" " " + Triphenyl stibine sulfide
" " sulfide + Triphenyl thio phosphate
" stibine + Triphenyl arsine

**TRIPHENYL TRIAZINE**, etc.

Freezing-point data for mixtures of triphenyl triazine and methyl diphenyl triazine and for triphenyl triazine and triazine tricarboxylate of ethyl are given by Pascal, 1925.

**TRIPHENYL AMINE** $(C_6H_5)_3N$.

100 gms. 96 % ethyl alcohol dissolve 0.74 gm. $(C_6H_5)_3N$ at 19°-20°. 5 and 5.5 gms. at 74°.
100 gms. 98.5 % methyl alcohol ($d_{\frac{15}{4}} = 0.7998$) dissolve 0.73 gm. $(C_6H_5)_3N$ at 19°-20°. 5 and 3.3 gms. at 74°. (Boldyrev, 1916.)

F.-pt. data are given by Pascal (1912) for the following mixtures:

Triphenylamine + Triphenylarsine
Triphenylamine + Triphenylphosphine
Triphenylarsine + Triphenylphosphine
Triphenylarsine + Triphenyl Stibene
Triphenylarsine + Triphenylbismuthine
Triphenylphosphine + "

**PHENYL PHOSPHATE**, Thiophosphate, Phosphine Oxide, etc.

Freezing-point lowering data are given by Pascal. 1923, for the following mixtures.

Phenyl phosphate $PO(OC_6H_5)_3$ + Phenyl thiophosphate $PS(OC_6H_5)_3$.
" " + Triphenyl phosphine oxide $PO(C_6H_5)_3$.
Phenylthiophosphate $PS(OC_6H_5)_3$ + " " sulfide $PS(C_6H_5)_3$.
Triethylphosphine sulfide $PS(C_2H_5)_3$ + " " "
Phenylphosphate $PO(OC_6H_5)_3$ + Phenylmethylphosphate $CH_3PO(OC_6H_5)_3$.
Triphenylphosphine oxide $PO(C_6H_5)_3$ + Triphenyl phosphine sulfide $PS(C_6H_5)_3$.

**DIPHENYL -p- PHENYLENE DIAMINE** $N,N'(C_6H_5)_2NC_6H_4NH_2$.

Freezing-point data for mixtures of diphenyl p phenylene diamines are given by Dilthey and Escherich, 1933.

**RETENE** $C_{18}H_{18}$.

Freezing-point data are given for mixtures of retene and:

| | | |
|---|---|---|
| Anthracene(6) | Picramide(1) | Tetryl(5) |
| Phenanthrene(6) | Picryl chloride(1) | Tri nitro cresol(4) |
| Picric acid(1) | Styphnic acid(1)(3) | " " toluene(2) |
| | | " " xylene(5) |

(1) Jefremow, 1918; (2) Jefremow, 1919; (3) Jefremow, 1919a; (4) Jefremow and Tichomirowa, 1927; (5) Jefremow and Tichomirowa, 1928; (6) Pascal, 1921.

**VESUVIN** (Phenylene bis azo-m-phenylene diamine HCl.)
$C_6H_4[N_2C_6H_3(NH_2)_2]_2.HCl$.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 100 gms. water | | dissolve | 8.5 gms. | vesuvin | at 20–25°. | | (Dehn, 1917.) |
| " | pyridine | " | 11.1 | " | " | " | " |
| " | aq. 50% pyridine | " | 31.4 | " | " | " | " |

**SALIPYRINE** $C_{11}H_{12}N_2O.C_6H_4.OH.COOH$.

Solubility of Salipyrine in Aqueous Solutions of Antipyrine and of Sodium Salicylate at 18°. (Kolthoff, 1927.)

The determinations were made by electrolytic conductivity measurements. At 18° the conductivity of the saturated solution of salipyrine in water was $1.00 \times 10^{-3}$ rec. ohms. The $p_H$ of the solution was 2.6 and the calculated $[H^+] = 2.5 \times 10^{-3}$.

In Aq. $C_{11}H_{12}N_2O$.

| Gm. mols. per liter. | |
|---|---|
| $C_{11}H_{12}N_2O$. | Salipyrine. |
| 0.0 ($H_2O$) | 0.0132 |
| 0.025 | 0.00712 |
| 0.05 | 0.00520 |
| 0.10 | 0.00432 |

In Aq. $C_6H_4OHCOONa$.

| Gm. mols. per liter. | |
|---|---|
| $C_6H_4OHCOONa$. | Salipyrine. |
| 0.05 | 0.0114 |
| 0.10 | 0.0122 |
| 0.20 | 0.0126 |

Freezing-point data are given for mixtures of:

Salipyrine + Acetanilide (Hrynakowski and Adamanis, 1933a.)
" + " + Sulfonal (Hrynakowski and Staszewski, 1936.)
" + Antipyrine + Urea (Hrynakowski, 1934.)
" + Sulfonal (Hrynakowski and Adamanis, 1933a.)
" + " + Urea (Hrynakowski and Szmyt, 1938a.)

**AZO BENZOIC ACID ETHYL ESTER** p $C_2H_5OOCC_6H_4N{:}NC_6H_4COOC_2H_5$.

Freezing-point data for mixtures of the azo and azoxy benzoic acid ethyl esters are given by de Kock, 1904.

Hexamethyl **MELLITIC ACID** Ester $C_6(COOCH_3)_6$.

Data for the terhary system hexamethyl mellitic acid ester, phenol and water are given by Timmermans (1907)

**CODEINE** $C_{18}H_{21}NO_3.H_2O$.

**CODEINE PHOSPHATE** $C_{18}H_{21}NO_3.H_3PO_4.2H_2O$.

**CODEINE SULFATE** $(C_{18}H_{21}NO_3)_2.H_2SO_4.5H_2O$.

SOLUBILITY OF EACH SEPARATELY IN SEVERAL SOLVENTS.

| Solvent. | t°. | Gms. per 100 Gms. Solvent. Codeine. | C. Phosphate. | C. Sulfate. | Authority. |
|---|---|---|---|---|---|
| Water | 25 | 0.80–1.7 | 44.9 | 3.3 | (U.S.P.; Baroni and Barlinetto, |
| " | 20 | 0.84 | ... | ... | (Zalai 1910.) [1911.) |
| " | 80 | 1.70 | 227 | 16 | (U. S. P.) |
| Alcohol (92.3 Wt. %) | 25 | 63.7 | 0.383 | 0.1 | (Schaeffer, 1913; U. S. P.) |
| " " | 60 | 108.7 | 1.03 | 0.27 | (U. S. P.) |
| Methyl Alcohol | 25 | 62.8 | ... | 0.56 | (Schaeffer, 1913.) |
| Chloroform | 25 | 133–151 | 0.015 | 0.007 | (Schaeffer, U. S. P.) |
| Carbon Tetrachloride | 20 | 2.94–1.33 | ... | ... | (Gori, 1913; Beilstein, Suppl.) |
| Ether | 25 | 8 | 0.075 | .... | (U. S. P.) |
| Benzene | 25 | 11.4 | ... | Insol. | (Schaeffer, 1913.) |
| Trichlorethylene | 15 | 12 | ... | ... | (Wester and Bruins, 1914.) |
| 3 Gms. $H_3BO_3$ per 100 cc. aq. 50% Glycerol | ord. t. | 4 | ... | ... | (Baroni and Barlinetto, 1911.) |

100 gms. trichlorethylene dissolve 0.014 gm. codeine hydrochloride at 15°. (Wester and Bruins, 1914.)

Data for the solubility of codeine and codeine sulfate in mixtures of alcohols, benzene and chloroform are given by Schaeffer (1913).

100 gms. Pet. Ether dissolve 0.14–0.22 gm. codeine at 25°. (Warren, 1933.)
100 cc Olive oil dissolve 1.6 gms. codeine at 25°. (Walton, 1935.)

**CODEINE TRICHLOR ACETATE** $C_{18}H_{21}O_3N.CCl_3COOH.2H_2O$.

100 gms. sat. solution of codeine trichlor acetate in water contain 2.81 gms. of the salt (?.$2H_2O$) at 15° and 23.71 gms. at 54.5°. (Florence, 1927.)

**CODEINE HYDROCHLORIDE** $C_{18}H_{21}NO_3.HCl.2H_2O$.

100 gms. $H_2O$ dissolve 3.51 gms. $C_{18}H_{21}NO_3.HCl.2H_2O$ at 15°.5. (Wilson. 1923.)

**CODEINE PICRATE** $C_{18}H_{21}NO_3.HO.C_6H_2(NO_2)_3$ (m. pt. 196°.7).

100 gms. sat. solution of codeine picrate { in water contain 0.11 gm. $C_{18}H_{21}NO_3.HOC_6H_2(NO_2)_3$ at 20° / in abs. alcohol » 0.095 » » » » / in acetone » 3.89 » » » »

(Maplethorpe and Evers, 1925.)

**BORNYL PHTHALATE** acid-d- $C_{10}H_{17}OCOC_6H_4COOH$.

Freezing-point data for mixtures of the d and l compound are given by Ross and Somerville, 1926.

**LINOLENIC HEXABROMIDE** $C_{18}H_{30}Br_6O_2$.

Qualitative determination of the solubility of linolenic hexabromide and of its Ba, Pb, K and Zn salts in 28 solvents are given by Imperial and West, 1926.

**LINOLEIC ACID** $C_{18}H_{32}O_2$.

Freezing-point data for mixtures of linoleic acid with iso oleic, with oleic , with palmitic and with stearic acids are given by Koczy and Griengl, 1931.

$C_{18}H_{30}O_{15}$

**Tri AMYLOSE** $[C_6H_{10}O_5]_3.4H_2O$, **β Hexa AMYLOSE** $[C_6H_{10}O_5]_6.9H_2O$.

SOLUBILITY OF EACH IN WATER.

(Pringsheim and Dernikos, 1922.)

The compounds were each dissolved in water by warming and the solutions allowed to stand at 20° untill completely crystallized.

100 gms. of the sat. solution of Tri amylose contain 1.39 gms. of the anhydrous compound.

100 gms. of the sat. solution β-Hexa amylose contain 2.40 gms. of the anhydrous compound.

The accuracy of the above results is questioned by Karrer, 1922, who found no difference in the solubility when the finely powdered compounds were shaken with water at the same temperature.

**α ELEOSTEARIC ACID** $C_{17}H_{31}COOH$.

SOLUBILITY OF α ELEOSTEARIC ACID IN AQUEOUS ETHYL ALCOHOL AT 0°.

(Ku, 1937.)

| Vol. % $C_2H_5OH$ in aq. solvent | Gms. $C_{17}H_{31}COOH$ per 100 gms. sat. sol. | Vol. % $C_2H_5OH$ in aq. solvent | Gms. $C_{17}H_{31}COOH$ per 100 gms. sat. sol. |
|---|---|---|---|
| 54.84 | 0.023 | 76.05 | 0.614 |
| 59.61 | 0.070 | 80.33 | 0.983 |
| 70.19 | 0.113 | 90.14 | 3.28 |

100 gms. sat. solution of α eleostearic acid in nitro benzene contain 3.75 gms. $C_{17}H_{31}COOH$ at 0°. (Ku, 1937.)

**STEAROLIC ACID** $CH_3(CH_2)_7C{:}C(CH_2)_7COOH$.

Freezing-point data are given by Rheinboldt and Lauber, 1929, for mixtures of stearolic acid with cholic acid and with hyodesoxy cholic acid.

**CHAULMOOGRIC ACID** $\underline{CH{:}CHCH_2CH_2CH}(CH_2)_{12}COOH$.

Freezing-point data are given by Cole and Cardoso, 1937, for mixtures of chaulmoogric acid with hydnocarpic acid and for mixtures of hydnocarpic acid with palmitic acid.

**RAFFINOSE** $C_{18}H_{32}O_{16} + 5H_2O$.

SOLUBILITY OF RAFFINOSE IN MIXTURES OF WATER AND PYRIDINE AT 25°.

(Pucher and Dehn, 1921.)

A high degree of accuracy is not claimed for the results. Constant agitation was evidently not employed to insure saturation. The solutions were analyzed by evaporation and weighing the residue.

| Per cent $C_5H_5N$ In solvent. | Gms. Raffinose per 100 gms. solvent. | Per cent $C_5H_5N$ In solvent. | Gms. Raffinose per 100 gms. solvent. | Per cent $C_5H_5N$ In solvent. | Gms. Raffinose per 100 gms. solvent. |
|---|---|---|---|---|---|
| 0.0 (=$H_2O$) | 29.83 | 60 | 6.51 | 92 | 24.7 |
| 10.0 | 23.12 | 70 | 5.32 | 94 | 36.9 |
| 20 | 22.16 | 80 | 7.40 | 96 | 41.9 |
| 50 | 18.88 | 81.4 | 4.49 | 98 | 45.7 |
| 40 | 13.42 | 90 | 24.50 | 160 | 79.08 |
| 50 | 9.94 | 91 | 24.6 | | |

100 gms. abs. alcohol dissolve 3.6 gms. raffinose at 20-25°.

100 gms. equi. molecular mixture of alcohol and quinoline dissolve 5.04 gms. raffinose at 20-25°.

(Pucher and Dehn, 1921.)

**RAFFINOSE** $C_{18}H_{32}O_{16} + 5\ H_2O$.

SOLUBILITY OF RAFFINOSE IN WATER.

(Hungerford and Nees, 1934.)

| t° | Gms. $C_{18}H_{32}O_{16}$ per 100 gms. sat. sol. | Gms. $C_{18}H_{32}O_{16}$ per 100 gms. Water | t° | Gms. $C_{18}H_{32}O_{16}$ per 100 gms. sat. sol. | Gms. $C_{18}H_{32}O_{16}$ per 100 gms. Water |
|---|---|---|---|---|---|
| 0.0 | 3.3 | 3.4 | 30 | 21.3 | 27.1 |
| 10.0 | 6.2 | 6.6 | 40 | 33.3 | 49.9 |
| 16.38 | 9.48 | 10.47 | 50 | 46.5 | 86.9 |
| 20.0 | 12.0 | 13.6 | 60 | 60.6 | 153.8 |
| 25.05 | 16.28 | 19.45 | 70 | 74.3 | 289.1 |
| | | | 78m.pt. | 84.84 | 559.63 |

The solid phase is $C_{18}H_{32}O_{16}\cdot 5H_2O$ in all cases.

The solubility of raffinose anhydride at 25° is about 1000 gms. per 100 gms. of $H_2O$ and the solution is too viscous to permit a rapid transition to the penta hydrate which is the stable form below 78°.

**OLEIC ACID** $C_8H_{17}CH{:}CH(CH_2)_7COOH$.

SOLUBILITY OF OLEIC ACID IN AQUEOUS ALCOHOL SOLUTIONS AT 25°.

(Seidell, 1910.)

Oleic acid of $d_{25} = 0.8935$ and containing 99.5% acid, determined by titration, was used. It was found that the addition of as little as one drop of this acid to aq. alcohol solutions containing up to 50 wt. % $C_2H_5OH$ caused an opalescence on shaking, therefore, indicating a solubility of less than about 0.05 gm. acid per 100 cc. water or of aq. alcohol. With solutions containing more than 50 wt. % $C_2H_5OH$ the following results were obtained:

| Wt. Per cent $C_2H_5OH$. | cc. Oleic Acid per 100 cc. Aq. Alcohol to produce cloudiness. | Remarks. |
|---|---|---|
| 51 | 0.08—0.2 | Cloudiness gradually increased. |
| 58.2 | 0.2 —0.4 | " " " |
| 65.5 | 0.3 —0.6 | Cloudiness disappeared when about 5.5 cc. acid had been added. |
| 70.2 | 0.6 —1 | " " " " 4.5 cc. " " " " |
| 81.4 | ∞ | No cloudiness appeared at all. |

It was found that although the end points obtained by addition of oleic acid to aq. alcohol mixtures are not sharp, they become so when the procedure is changed to addition of $H_2O$ to mixtures of oleic acid and alcohol. By this method perfectly clear liquid may be transformed by one drop of the $H_2O$ to an opalescent mixture which, after standing a few minutes, separates into two liquid layers. Determinations made in this way gave the following observed and calculated quantities.

Gms. of Constituents to Yield Opalescent Mixtures.

| Alcohol + Oleic Acid Mixture. $C_2H_5OH$. | Alcohol + Oleic Acid Mixture. Oleic Acid. | $H_2O$ Added to Cause Separation. |
|---|---|---|
| 15.30 | 1.794 | 10.4 |
| 15.30 | 3.588 | 10.2 |
| 15.30 | 4.485 | 9.8 |
| 15.30 | 7.175 | 9.25 |
| 15.30 | 11.210 | 8.05 |
| 24.42 | 22.420 | 10.10 |
| 15.30 | 20.810 | 6.50 |
| 1.195 | 8.969 | 0.321 |

Results Calculated from the Plotted Curve.

| Wt. Per cent $C_2H_5OH$ in Aq. Alcohol. | cc. Oleic Acid per 100 cc. Aq. Alcohol. | Gms. Oleic Acid per 100 Gms. Sat. Sol. |
|---|---|---|
| 57 | ... | 0 |
| 58.5 | 0 | 5 |
| 60 | 11 | 12.3 |
| 62.5 | 30 | 20 |
| 65 | 49 | 30.5 |
| 67.5 | 69 | 40 |
| 70 | 91 | 50 |
| 75.5 | ... | 68.5 |
| 80 | ... | 88 |

After standing 24 hours the opalescent mixtures separated into layers which, on analysis, gave the results shown in the following table:

COMPOSITION OF UPPER AND LOWER LAYERS OBTAINED BY THE ADDITION OF WATER TO MIXTURES OF AQUEOUS ALCOHOL AND OLEIC ACID AT 25°.

| Composition of Original Mixture. | | | After Separation into Two Layers: | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | Lower Layer. | | | Upper Layer. | | |
| Wt. % $C_2H_5OH$ in Aq. Alc. Used. | cc. Aq. Alcohol Mixture. | cc. Oleic Acid. | cc. $H_2O$ to Cause Separation. | cc. Total Vol. | Sp. Gr. | cc. Oleic Acid. | cc. Total Vol. | Sp. Gr. | cc. Oleic Acid. |
| 70.2 | 25 | 2 | 3.90 | 29 | 0.893 | 1.48 | 1 | ... | 0.35 |
| 70.2 | 25 | 4 | 3.70 | 26 | 0.890 | 1.89 | 6 | 0.875 | 1.98 |
| 65.5 | 26.5 | 5 | 1.75 | 22.7 | 0.891 | 1.93 | 9.3 | 0.875 | 2.78 |
| 70.2 | 25 | 8 | 2.75 | 16 | 0.893 | 0.98 | 19 | 0.876 | 6.59 |
| 70.2 | 25 | 12.5 | 1.55 | 6 | 0.890 | 0.37 | 33.2 | 0.878 | 11.87 |
| 70.2 | 35 | 25 | 1 | 4.5 | ... | 0.28 | 55.5 | 0.877 | 24.14 |

The $C_2H_5OH$ in the two layers could not be determined on account of excessive foaming during distillation of the neutralized solution. Some losses occurred in transferring the original mixtures to the graduated cylinders and differences between final amounts and those originally present are due to these losses.

SOLUBILITY OF OLEIC ACID IN AQUEOUS ETHYL ALCOHOL AT 0°.

(Ku, 1937.)

| Vol. % $C_2H_5OH$ in aq. solvent | Gms. $C_{18}H_{34}O_2$ per 100 gms. sat. sol. | Vol. % $C_2H_5OH$ in aq. solvent | Gms. $C_{18}H_{34}O_2$ per 100 gms. sat. sol. |
|---|---|---|---|
| 54.84 | 0.20 | 73.93 | 4.06 |
| 59.61 | 0.42 | 75.07 | 7.06 |
| 70.19 | 1.82 | 76.05 | 28.00 |
| 71.87 | 2.44 | | |

SOLUBILITY OF OLEIC ACID IN AQUEOUS SOLUTIONS OF BILE SALTS.

(Moore, Wilson and Hutchinson, 1909.)

| Solvent. | Gms. Oleic Acid per 100 Gms. Sat. Sol. |
|---|---|
| Water | less than 0.1 |
| 5% Aq. Solution of Bile Salts | about 0.5 |
| 5% Aq. Solution of Bile Salts + 1% Lecithin | 4 |

## OLEIC ACID $C_8H_{17}CH : CH(CH_2)_7COOH$.

SOLUBILITY OF OLEIC ACID IN SEVERAL SOLVENTS AT 0°. (Lebrun, 1925, 1930.)

| Solvent. | B. pt. of solvent. | Gms. $C_{18}H_{34}O_2$ per 100 gms. solvent. |
|---|---|---|
| Dichlor acetylene (cis) | 60°.2 | >100 |
| » » (trans) | 48°.3 | >100 |
| Ethyl chloroisocrotonate | - | >100 |
| Bromo butene-2 | 85°.5–85°.6 | >100 |
| » » -2 | 93°.9 | >100 |
| Crotonic nitrile | 107°.7–108°.2 | 39.1 |
| » » | 121°.8–122°.2 | 30.2 |

DISTRIBUTION OF OLEIC ACID BETWEEN AQUEOUS ALCOHOL AND BENZINE. (Holde,'10.)

| Strength of Aq. Alcohol in Vol. Per cent. | Gm. (Approx.) of Oleic Acid in: | | Dist. Coef. |
|---|---|---|---|
| | 50 cc. Aq. Alcohol Layer. | 50 cc. Benzine Layer. | |
| 84.1 | 0.277 | 0.723 | 2.61 |
| 76.9 | 0.112 | 0.888 | 7.93 |
| 63.7 | 0.025 | 0.975 | 39 |
| 50.5 | 0.006 | 0.994 | 166 |
| 42.4 | 0.002 | 0.998 | 499 |

SOLIDIFICATION-POINTS OF MIXTURES OF OLEIC AND STEARIC ACIDS. (Meldrum, '13.)

| Solidification Temp. | Per cent Oleic Acid in Mixture. | Solidification Temp. | Per cent Oleic Acid in Mixture. |
|---|---|---|---|
| 0 | 54.8 | 50 | 44.7 |
| 10 | 53.3 | 60 | 41.2 |
| 20 | 51.6 | 70 | 36.6 |
| 30 | 49.7 | 80 | 30.5 |
| 40 | 47.6 | | |

Additional data for the above system as well as for mixtures of oleic and palmitic acids and for the ternary system oleic, palmitic and stearic acids are given by Carlinfante and Levi-Malvano (1909). Results for Oleic Acid + Stearic acid are also given by Fokin (1912).

Freezing-point data are also given for mixtures of:

Oleic acid + Palmitic acid (Smith, 1939; Koczy and Griengl, 1931.)
" " + Stearic acid " " " " " "
" " + " " + Palmitic (Dubovitz, 1928.)
" " + Elaidic acid (Griffiths and Hilditch, 1932.)
" " + Erythritol (Puschin and Dezelic, 1932.)
" " + Glycerol " " " "
" " + Linoleic acid (Koczy and Griengl, 1931.)

The melting-point depressions of mixtures of oleic acid and other fatty acids were used by Wenzel, 1934, as a method for estimating the percentage of individual fatty acids in mixtures.

## TriOLEIN $(C_{18}H_{33}O_2)_3C_3H_5$.

SOLIDIFICATION-POINTS OF MIXTURES OF TRIOLEIN AND OTHER FATS.
(Kremann and Schoulz, 1912.)

| Triolein + Tripalmitin. | | Triolein + Tristearin. | | Tripalmitin + Tristearin. | |
|---|---|---|---|---|---|
| t°. | Wt. Per cent Triolein. | t°. | Wt. Per cent. Triolein. | t°. | Wt. Per cent Tristearin. |
| − 7 | 100 | +28 | 95.2 | 60.4 | 90 |
| +25 | 93.9 | 44 | 85.3 | 58 | 75 |
| 48.2 | 78.5 | 50.7 | 76.7 | 57.8 | 69.4 |
| 50 | 73.9 | 56 | 68.8 | 56 | 60.2 |
| 56.9 | 53 | 64.3 | 47.2 | 57.2. | 53 |
| 60.9 | 27.2 | 64.3 | 25.4 | 55.1 | 43.8 |
| 62.6 | 0 | 56 | 0 | 54.5 | 31.2 |
| | | | | 60.4 | 8.4 |

Data for the ternary system, triolein, tripalmitin and tristearin are also given.

## PETROSELINIC ACID $CH_3(CH_2)_{10}CH{:}CH(CH_2)_4COOH$.

Freezing-point data for mixtures of the cis and trans compound are given by Griffiths and Hilditch, 1932.

## ELAIDIC ACID $C_8H_{17}CH:CH(CH_2)_7COOH$.

### Solubility of Elaidic Acid in Several Sterioisomeric Solvents.

(Lebrun, 1925, 1930.)

| Solvent | b. pt. of solvent | t° | Gms. $C_{18}H_{34}O_2$ per 100 gms. solvent |
|---|---|---|---|
| Dichlor acetylene (cis) | 60.2 | 0 | 6.20 |
| " " (trans) | 48.3 | 0 | 10.97 |
| β Ethyl chloro iso crotonate(cis) | — | 20 | 47.4 |
| Bromo butane-2(cis) | 94.9 | 0 | 3.68 |
| " " -2(trans) | 85.5- 85.6 | 0 | 4.10 |
| Crotonic nitrile | 107.7-108.2 | 25 | 17.45 |
| " " | 121.8-122.2 | 25 | 12.33 |

Freezing-point data are given for mixtures of:

Elaidic acid + Erythritol (Puschin and Dezelic, 1932.)
" " + Oleic acid (Griffiths and Hilditch, 1932.)
" " + Palmitic acid (Smith, 1939.)
" " + Stearic acid " "

## STEARIC ACID $CH_3(CH_2)_{16}COOH$.

100 gms. $H_2O$ dissolve 0.1 gm. stearic acid at 37°.
100 gms. 5% aqueous solution of bile salts dissolve less than 0.1 gm. stearic acid.
100 gms. 5% aq. sol. of bile salt + 1% lecithin dissolve 0.2 gm. stearic acid.
In the same solvents there is dissolved of sodium stearate, 0.1, 0.2 and 0.7 gm. respectively. (Moore, Wilson and Hutchinson, 1909.)

## STEARIC ACID $CH_3(CH_2)_{16}COOH$.

### Solubility of Stearic Acid in Aqueous Ethyl Alcohol Solutions.

(Thomas and Yu, 1923; Thomas and Mattikow, 1926.)

| Wt. % $C_2H_5OH$ in solvent. | $d_{\frac{25}{4}}$ of Solvent. | Gms. $CH_3(CH_2)_{16}COOH$ per 100 cc. sat. solution at | | |
|---|---|---|---|---|
| | | 0° ± 1°.0 (*a*). | 10° ± 0°.5 (*b*). | 25° ± 0°.05 (*c*). |
| 63.07 | 0.8778 | — | 0.031 | 0.087 |
| 86.16 | 0.8236 | 0.061 | 0.232 | 1.014 |
| 91.53 | 0.8094 | 0.113 | 0.396 | 1.803 |

(*a*) The mixtures were shaken 4 times daily for 5 ½ days and the determinations repeated ofter another period of 5 ½ days.

(*b*) The mixtures were shaken 2 times daily for 10 days and the determinations repeated ofter another period of 3 days.

(*c*) Saturation was obtained by constant agitation in a thermostat.

100 gms. methyl formate dissolve 1.3 gms. stearic acid at 25°. (Kröber, 1919.)

### Solubility of Stearic Acid in Aqueous Ethyl Alcohol at 0°.

(Ku, 1937.)

| Vol. % $C_2H_5OH$ in aq. solvent | Gms. $C_{18}H_{36}O_2$ per 100 gms. sat. sol. | Vol. % $C_2H_5OH$ in aq. solvent | Gms. $C_{18}H_{36}O_2$ per 100 gms. sat. sol. |
|---|---|---|---|
| 58.84 | 0.048 | 76.05 | 0.22 |
| 59.61 | 0.070 | 80.33 | 0.37 |
| 70.16 | 0.113 | 90.14 | 0.88 |

### Solubility of Stearic Acid in Aqueous Ethyl Alcohol at 25°.

(Seidell, 1910.)

| Wt. % $C_2H_5OH$ in Solvent. | $d_{25}$ of Sat. Sol. | Gms. $C_{17}H_{35}COOH$ per 100 Gms. Sat. Sol. | Wt. % $C_2H_5OH$ in Solvent. | $d_{25}$ of Sat. Sol. | Gms. $C_{17}H_{35}COOH$ per 100 Gms. Sat. Sol. |
|---|---|---|---|---|---|
| 0 | 0.999 | 0.034 | 70 | 0.865 | 0.80 |
| 20 | 0.967 | 0.04 | 80 | 0.841 | 1.63 |
| 40 | 0.932 | 0.10 | 90 | 0.818 | 3.30 |
| 50 | 0.911 | 0.18 | 95 | 0.807 | 5.55 |
| 60 | 0.888 | 0.40 | 100 | 0.795 | 8.30 |

100 cc. sat. sol. in { 94.3 Vol. % $C_2H_5OH$ contain 0.0996 gm. $C_{17}H_{35}COOH$ at 0° ($d_0 = 0.8318$). 95.1 " " " 0.1139 " " " " ($d_0 = 0.8287$). 95.7 " " " 0.1246 " " " " ($d_0 = 0.8265$).

Saturation was approached from above without constant agitation. (Emerson, 1907.)

### Solubility of Stearic Acid in Ethyl Alcohol at Several Temperatures.

(Falciola, 1910.)

| t°. | Gms. $C_{17}H_{35}COOH$ per 100 cc. of: | | |
|---|---|---|---|
| | Absolute Alcohol. | 75% Alcohol. | 50% Alcohol. |
| 10 | 0.9 | 0.15 | ... |
| 20 | 2 | ... | 0.08 (23°) |
| 30 | 4.5 | 0.39 | 0.10 |
| 40 | 13.8 | 0.77 | 0.12 |

100 cc. sat. solution in 94.4 Vol. % $CH_3OH$ ("methylated alcohol" of $d$ = 0.8183) contain 0.15 gm. $C_{17}H_{35}COOH$ at +0.2°. Saturation was approached from above without constant agitation. (Hehner and Mitchell, 1897.)

### Solubility of Stearic Acid in Several Solvents at 25°.

(Seidell, 1910.)

| Solvent. | $d$ of Solvent. | $d_{25}$ of Sat. Sol. | Gms. $C_{17}H_{35}COOH$ per 100 Gms. Sat. Sol. |
|---|---|---|---|
| Acetone | $d_{15} = 0.797$ | 0.815 | 4.73 |
| Amyl Alcohol (iso) | $d_{20} = 0.817$ | 0.815 | 9.43 |
| Amyl Acetate | $d_{20} = 0.875$ | 0.867 | 11.19 |
| Carbon Disulfide | $d_{25} = 1.259$ | 1.163 | 19.20 |
| Carbon Tetrachloride | $d_{25} = 1.587$ | 1.465 | 10.25 |
| Chloroform | $d_{22} = 1.476$ | 1.332 | 15.54 |
| Ether (abs.) | $d_{22} = 0.711$ | 0.744 | 20.04 |
| Ethyl Acetate | $d_{25} = 0.892$ | 0.895 | 7.36 |
| Nitrobenzene | $d_{25} = 1.205$ | 1.199 | 1.24 |
| Toluene | $d_{15} = 0.872$ | 0.865 | 13.61 |

Fusion-point data for stearic acid + tristearin and for stearic acid + tristearin + palmitic acid are given by Kremann and Kropsch (1914).

## STEARIC ACID

Freezing-point data are also given for mixtures of Stearic acid and:

Apocholic acid(10)
Arachidic acid(16)
Cholic acid(11)
Desoxy cholic acid(10)
Elaidic acid(14)
Erythritol(9)
Glycerol(9)
Hyodesoxy cholic acid(11)
Iso oleic acid(15)
Linoleic acid(15)
Mannitol(9)
Margaric acid(12)(13)
Margaric acid + Palmitic acid(12)
Naphthalene(2)
Oleic acid(14)(15)
Palmitic acid(5)(6)(12)
" " + oleic(1)(3)(4)(8)
Tri palmitin(7)

(1) Carlinfanti and Levi-Malvano, 1909; (2) Courtonne, 1882; (3) Dubovitz, 1928; (4) Fokin, 1912; (5) Giua, 1916; (6) Jefremow, 1927a; (7) Kremann and Klein, 1913; (8) Meldrum, 1913; (9) Puschin and Dezelic, 1932; (10) Rheinboldt, Flume and König, 1927; (11) Rheinboldt and Lauber, 1929; (12) Shriner, Fulton and Burks, 1933; (13) Smith, 1936; (14) Smith, 1939; (15) Koczy and Griengl, 1931; (16) von Meyer, Brod and Soyka, 1913.

The melting-point depressions of mixtures of stearic and other fatty acids were used by Wenzel, 1934, as a method for estimating individual fatty acids in mixtures.

## DISTEARINS

### Solubility of Di Stearins in Several Solvents.

(Robinson, Roche and King, 1932.)

Ten cc. of the solvent were saturated at 50° with the glyceride and then shaken for several hours at the temperature of the experiment. One cc. of each saturated solution was withdrawn and evaporated to dryness and the residue weighed. All solvents were anhydrous.

| Di Stearin | M. pt. | Solvent | t° | Gms. di stearin per 100cc solvent |
|---|---|---|---|---|
| α Capro-α'β-di stearin | 48.2 | Acetone | 29.0 | 39.45 |
| β " α,α' " | 56.2 | " | 29.0 | 2.57 |
| α " α',β " | 48.2 | Alcohol | 27.5 | 0.22 |
| β " α',α' " | 56.2 | " | 27.5 | 0.14 |
| α Lauro α' β " | 50.6 | Pet. Ether | 27.5 | 38.41 |
| β " α,α' " | 59.8 | " " | 27.5 | 11.42 |
| α Myristo α',β " | 58.5 | Alcohol | 29.0 | 0.59 |
| β " α',α' " | 63.5 | " | 29.0 | 0.47 |
| α Palmito α',β " | 62.6 | " | 27.5 | 0.42 |
| β " α,α' " | 68.0 | " | 27.5 | 0.10 |
| α " α'β " | 62.6 | Acetone | 27.5 | 1.82 |
| β " α,α' " | 68.0 | " | 27.5 | 0.61 |

## TRI STEARIN $C_3H_5[CH_3(CH_2)_{16}CO_2]_3$.

### Solubility of Tristearin in Several Solvents.

(Loskit, 1928.)

The determinations were made by the thermic, the sealed tube and the analytical methods. The author's results were plotted and the following values estimated from the curves.

| t° | Gms. $C_3H_5[CH_3(CH_2)_{16}CO_2]_3$ per 100 gms. sat. solution in: | | | | |
|---|---|---|---|---|---|
| | $C_6H_6$ | $(C_2H_5)_2O$ | $CHCl_3$ | $(C_2H_5OH)$ | $CS_2$ |
| 5 | 0.7 | — | 1.0 | — | — |
| 10 | 1.0 | — | 3.5 | — | 0.2 |
| 15 | 1.5 | — | 6.7 | — | 0.5 |
| 20 | — | 0.3 | 10.5 | 0.02 | 1.0 |
| 25 | 4.2 | 0.5 | 15.0 | — | 1.6 |
| 30 | 7.0 | 2.0 | 20.0 | — | 4.5 |
| 35 | 12.5 | 5.5 | 27.0 | — | 12.0 |
| 40 | 23.0 | 13.5 | 34.0 | — | 24.5 |
| 45 | 37.0 | 27.5 | 42.5 | — | 40.0 |
| 50 | 51.0 | 43.0 | 51.0 | 0.03 | 51.5 |
| 60 | 75.0 | 72.5 | 71.0 | 0.15 | 72.0 |
| 70 | 93.0 | 94.0 | 94.0 | 0.6(65°) 1.2(67°) | 91.0 |

Similar results are also given for Tri palmitin, Tri myristin, Tri laurin and Tri caprin. Results for the solubility of Tri acetin, Tri butyrin, Tri capronin and Tri caprylin in benzene are also given by Loskit.

Freezing-point data are given for mixtures of Tri stearin and:

| | | | |
|---|---|---|---|
| Palmitic acid | + | stearic acid | (Kremann and Kropsch, 1914.) |
| " " | + | tri palmitin | " " " " |
| Stearic acid | + | " " | " " " " |
| Tri olean | + | " " | (Kremann and Schoulz, 1912.) |
| Tri palmitin | | | (Meldrum, 1913.) |

## PHENACYL STEARATE $CH_3(CH_2)_{16}COO.CH_2COC_6H_5$ etc.

### Solubility of Phenacyl, Bromo phenacyl and Chloro-Phenacyl Stearates in 95% Ethyl Alcohol.

(Hann, Reid and Jameson, 1930.)

| Stearate | Formula | Gms. Stearate per 100cc 95% alcohol at: 20° | 25° |
|---|---|---|---|
| Phenacyl Stearate | $CH_3(CH_2)_{16}COO.CH_2COC_6H_5$ | 0.2160 | 0.3650 |
| p Bromo Phenacyl Stearate | $CH_3(CH_2)_{16}COOCH_2COC_6H_4Br$ | 0.0200 | 0.0260 |
| p Chloro " " | $CH_3(CH_2)_{16}COOCH_2COC_6H_4Cl$ | 0.0648 | 0.1000 |

100 gms Abs. Alcohol dissolve 13.0 gms stearin at 20-25°. (Pucher and Dehn, 1921.)

" Quinoline " 5.35 " " " "

**STEARAMIDE** $CH_3(CH_2)_{16}CONH_2$.

Freezing-point data for mixtures of stearamide and palmitamide are given by Guy and Smith, 1939.

**STEARIC ANHYDRIDE** $(C_{17}H_{35}CO)_2O$.

100 gms. abs. alcohol dissolve 0.023 gm. stearic anhydride at 20°. (Whitby, 1926.)

**ETHYL PALMITATE** $CH_3(CH_2)_{14}COOC_2H_5$.

Freezing-point data for mixtures of ethyl palmitate with ethyl stearate and with ethyl margarate are given by Smith, 1931.

Ethylene, Propylene, etc. **GLYCOL ESTERS.**

SOLUBILITY OF STEARIC, AND PALMITIC ESTERS OF ETHYLENE, PROPYLENE AND TRIMETHYLENE GLYCOL IN ABSOLUTE ALCOHOL AT 0° AND 15°.

(Howe, 1918.)

Saturated solutions were prepared at a temperature slightly above 15° and these were kept for 16 hours in a thermostat at 15°. About 10 cc. of the clear supernatant solution were withdrawn, weighed accurately and the alcohol evaporated and the residue dried at 95° and weighed. The remainder of the saturated solution was placed in a mixture of melting ice and kept at 0° in a refrigerator for several hours. The supernatant solution was again analyzed as before.

| Compound. | Formula. | M. pt. | Gms cmpd. per 100 gms. $C_2H_5OH$ at 0°. | Gms cmpd. per 100 gms. $C_2H_5OH$ at 15°. |
|---|---|---|---|---|
| Mono Stearic Ester of Ethylene Glycol | $CH_2OH.CH_2(C_{18}H_{35}O_2)$ | 58.5 | 0.67 | 2.0 |
| Di » » » » | $CH_2(C_{18}H_{35}O_2).CH_2(C_{18}H_{35}O_2)$ | 75.0 | 0.01 | 0.02 |
| Mono Palmitic » » » | $CH_2OH.CH_2(C_{16}H_{31}O_2)$ | 51.5 | 1.62 | 10.0 |
| Di » » » » | $CH_2(C_{16}H_{31}O_2)CH_2(C_{16}H_{31}O_2)$ | 68.7 | 0.018 | 0.055 |
| Mono Stearic » Propylene » | 1.2$CH_3CHOHCH_2(C_{18}H_{35}O_2)$ | 59.5 | 0.021 | 0.034 |
| Di » » » » | » $CH_3CH.C_{18}H_{35}O_2)CH_2(C_{18}H_{35}O_2)$ | 72.3 | 0.0012 | 0.0063 |
| Mono Palmitic » » » | » $CH_3CHOH.CH_2.C_{16}H_{31}O_2)$ | 54.2 | 0.0193 | 0.0907 |
| Di » » » » | » $CH_3CH(C_{16}H_{31}O_2)CH_2(C_{16}H_{31}O_2)$ | 68.8 | 0.0516 | 0.0115 |
| Mono stearic » Trimethylene » | 1.3$CH_2OHCH_2CH_2(C_{18}H_{35}O_2)$ | 60.5 | 0.01431 | 0.0305 |
| Di » » » » | » $CH_2(C_{18}H_{35}O_2)CH_2.CH_2(C_{18}H_{35}O_2)$ | 64.7 | 0.00126 | 0.00381 |
| Di Palmitic » » » | » $CH_2(C_{16}H_{31}O_2)CH_2.CH_2(C_{16}H_{31}O_2)$ | 56.2 | 0.0244 | 0.0517 |

**OCTA DECYL IODIDE** $CH_3(CH_2)_{16}CH_2I$.

Freezing-point data are given by Smith, 1932b, for mixtures of octa decyl iodide with hexa decyl (cetyl) iodide and with iodo hexa decane.

**OCTA DECANE** $CH_3(CH_2)_{16}CH_3$.

Freezing-point data are given for mixtures of:

Octa decane + Hexa decane (Smith, 1932b.)
" " + Hepta decane (Carey and Smith, 1933.)

**OCTA DECANOL** (Octa decyl alcohol) $CH_3(CH_2)_{16}CH_2OH$.

Freezing-point data are given for mixtures of:

Octa decanol + Hexa decanol (Smith, 1931; Carey and Smith, 1933.)
" " + Hepta decanol (Carey and Smith, 1933.)

**TRINITRO TRIPHENYL METHANE** p,p',p" $CH(C_6H_4NO_2)_3$.

Freezing-point data for mixtures of trinitro triphenyl methane and sarcosine anhydride are given by Pfeiffer and Angern, 1926.

**DIPIPERONAL ACETONE** $(CH:CHC_6H_3O_2CH_2)_2CO$.

Freezing-point data for mixtures of dipiperonal acetone and iodo biphenyl are given by Pfeiffer, Schmitz and Inoue, 1929.

**CINNAMYLIDENE β NAPHTHYLAMINE** $C_6H_5CH:CH.CH:N.C_{10}H_7$.

Freezing-point data for mixtures of cinnamylidene β naphthylamine and diphenyl butadien are given by Pascal, 1914.

**BENZOYL DIPHENYL** p $C_6H_5.CO.C_6H_4.C_6H_5$.

SOLUBILITY OF BENZOYL DIPHENYL IN AQUEOUS SOLUTIONS OF SULFURIC ACID AT 25°.
(Hammett and Chapman, 1934.)

| Gms. $H_2SO_4$ per 100 gms. aq. solvent | Gms. $C_{19}H_{14}O$ per 100 gms. sat. sol. |
|---|---|
| 70.34 | 0.00044 |
| 75.55 | 0.00552 |
| 77.40 | 0.0196 |
| 78.70 | 0.0434 |
| 79.77 | 0.2066 |

**TRIPHENYL BROMO** (and Chloro)**METHANE** $(C_6H_5)_3CBr$.

100 gms. $C_6H_6$ dissolve 39.5 gms. $(C_6H_5)_3CBr$ at 25°.
" " " " 85.8 " $(C_6H_5)_3CCl$ " " (Halford, 1931.)

Triphenyl **METHANE** $CH(C_6H_5)_3$.

SOLUBILITY IN ANILINE.
(Hartley and Thomas, 1906.)

By synthetic method, see page 292.

| t°. | Gms. $CH(C_6H_5)_3$ per 100 Gms. Solution. | Mol. per cent $CH(C_6H_5)_3$. | Solid Phase. |
|---|---|---|---|
| 23.0 | 5.4 | 1.85 | $CH(C_6H_5)_3.C_6H_5NH_2$ rhombs |
| 35.3 | 9.5 | 3.8 | " |
| 43.0 | 13.5 | 5.6 | " |
| 52.1 | 21.9 | 9.7 | " |
| 61.4 | 36.5 | 17.8 | " |
| 66.0 | 47.2 | 25.4 | " |
| 68.7 | 54.8 | 31.6 | " |
| 70.1 | 64.6 | 40.9 | " |
| 71.3 | 67.9 | 44.6 | " |
| 71.6 | 71.7 | 49.1 | " |
| 71.2 | 76.3 | 55.1 | " |
| 70.6 | 78.3 | 57.9 | " |
| 71.6 | 82.1 | 63.5 | $CH(C_6H_5)_3$ monoclinic |
| 74.3 | 84.9 | 68.2 | " |
| 82.1 | 91.7 | 80.9 | " |
| 87.3 | 96.1 | 90.2 | " |

100 gms. sat. solution of triphenyl methane in liquid sulfur dioxide contain 16 gms. $CH(C_6H_5)_3$ at ? t°. (DeCarli, 1927.)

Triphenyl **METHANE**

## Solubility of Tri Phenyl Methane in Carbon Bisulphide.

(Etard — Ann. chim. phys. [7] 2, 570, '94; below −80°, Arctowski — Z. anorg. Ch. 11, 273, '95.)

| t°. | Gms. $CH(C_6H_5)_3$ per 100 Gms. Solution. | t°. | Gms. $CH(C_6H_5)_3$ per 100 Gms. Solution. | t°. | Gms. $CH(C_6H_5)_3$ per 100 Gms. Solution. |
|---|---|---|---|---|---|
| −113.5 | 0.98 | −40 | 7.5 | 40 | 63.7 |
| −102 | 1.24 | −20 | 13.7 | 50 | 72.4 |
| − 91 | 1.56 | 0 | 25.8 | 60 | 78.6 |
| − 83 | 1.91 | +10 | 38.7 | 70 | 85.6 |
| − 60 | 3.4 | 20 | 43.2 | 80 | 92.2 |
| | | 30 | 52.9 | | |

## Solubility of Tri Phenyl Methane in Hexane and in Chloroform. (Etard.)

| t°. | Gms. $CH(C_6H_5)_3$ per 100 Gms. Solution in: | | t°. | Gms. $CH(C_6H_5)_3$ per 100 Gms. Solution in: | |
|---|---|---|---|---|---|
| | Hexane. | Chloroform. | | Hexane. | Chloroform. |
| −50 | ... | 10.5 | 30 | 12.5 | 48.8 |
| −30 | 1.2 | 15.2 | 40 | 20.0 | 56.1 |
| −20 | 1.6 | 19.0 | 50 | 25.8 | 63.8 |
| −10 | 2.2 | 23.5 | 60 | 45.7 | 71.7 |
| 0 | 3.5 | 28.9 | 70 | 62.0 | 79.8 |
| +10 | 5.6 | 35.0 | 80 | 78.5 | 87.2 |
| 20 | 8.3 | 41.5 | 90 | 97.0 | ... |

## Solubility of Tri Phenyl Methane in:

(Hartley and Thomas.)

### Pyrrole.

| t°. | Gms. $CH(C_6H_5)_3$ per 100 Gms. Sol. | Mol. per cent $CH(C_6H_5)_3$. | Solid Phase. |
|---|---|---|---|
| 24.6 | 24.3 | 8.1 | $CH(C_6H_5)_3.C_4H_4NH$ |
| 29.0 | 29.8 | 10.4 | " rhombs |
| 31.5 | 33.4 | 12.1 | " |
| 36.8 | 40.6 | 15.8 | $CH(C_6H_5)_3$ |
| 42.7 | 49.1 | 20.9 | " monoclinic |
| 46.9 | 56.0 | 25.9 | " |
| 53.2 | 63.9 | 32.8 | " |
| 60.0 | 72.3 | 41.8 | " |
| 63.9 | 76.7 | 47.4 | " |
| 68.5 | 81.9 | 55.6 | " |
| 71.1 | 84.4 | 59.8 | " |
| 80.0 | 91.5 | 74.8 | " |
| 89.2 | 97.6 | 91.8 | " |

### Thiophene.

| t°. | Gms. $CH(C_6H_5)_3$ per 100 Gms. Solution. | Mol. per cent $CH(C_6H_5)_3$. | Solid Phase. |
|---|---|---|---|
| 25.7 | 26.0 | 10.8 | $CH(C_6H_5)_3.C_4H_4S$ |
| 33.5 | 31.1 | 13.5 | " rhombs |
| 44.0 | 43.6 | 21.1 | " |
| 47.6 | 48.4 | 24.4 | " |
| 53.5 | 58.7 | 32.9 | " |
| 57.4 | 70.2 | 44.7 | " |
| 57.6 | 74.8 | 50.6 | " |
| 62.7 | 78.7 | 56.0 | $CH(C_6H_5)_3$ |
| 67.0 | 81.9 | 60.8 | " monoclinic |
| 67.2 | 82.1 | 61.3 | " |
| 74.2 | 87.4 | 70.5 | " |
| 79.0 | 90.3 | 76.3 | " |
| 87.2 | 96.2 | 89.9 | " |

F.-pt. data for triphenylmethane + naphthalene are given by Vignon (1891).

SOLUBILITY OF TRIPHENYL METHANE IN PYRIDINE. (Hartley and Thomas, 1906.)
Synthetic method used, see note, p. 292

| t°. | Gms. $CH(C_6H_5)_3$ per 100 Gms. Solution. | Mol. per cent $CH(C_6H_5)_3$. | Solid Phase. | t°. | Gms. $CH(C_6H_5)_3$ per 100 Gms. Solution. | Mol. per cent $CH(C_6H_5)_3$. | Solid Phase. |
|---|---|---|---|---|---|---|---|
| 22.8 | 46.2 | 22 | $CH(C_6H_5)_3$ | 59.3 | 75.6 | 50.3 | $CH(C_6H_5)_3$ |
| 31.7 | 53.3 | 27.2 | " monoclinic | 67.8 | 81.9 | 59.7 | " |
| 37.9 | 57.6 | 30.7 | " | 72.8 | 85.7 | 66.4 | " |
| 48.7 | 66.6 | 39.5 | " | 80.6 | 91.5 | 77.2 | " |
| 53.1 | 70.1 | 43.5 | " | 86.8 | 95.8 | 88.1 | " |

SOLUBILITY OF TRI PHENYL METHANE IN BENZENE.

(Linebarger — Am. Ch. J. 15, 45, '93.)

| t°. | Gms. $CH(C_6H_5)_3$ per 100 Grams $C_6H_6$. | Solid Phase. |
|---|---|---|
| 3.9 | 3.90 | $C_6H_6$ + $CH(C_6H_5)_3.C_6H_6$ |
| 4.0 | 4.06 | $CH(C_6H_5)_3.C_6H_6$ |
| 12.5 | 5.18 | " |
| 16.1 | 6.83 | " |
| 19.4 | 7.24 | " |
| 23.1 | 8.95 | " |
| 37.5 | 10.48 | $(C_6H_5)_3CH.C_6H_6$ + $CH(C_6H_5)_3$ |
| 42.0 | 19.61 | $CH(C_6H_5)_3$ |
| 44.6 | 22.64 | " |
| 50.1 | 30.64 | " |
| 55.5 | 40.51 | " |
| 71.0 | 140.00 | " |
| 76.2 | 319.67 | " |

(Hartley and Thomas.)

| t°. | Gms. $CH(C_6H_5)_3$ per 100 Gms. Solution. | Mol. per cent $CH(C_6H_5)_3$. | Solid Phase. |
|---|---|---|---|
| 33 | 12.6 | 4.4 | $CH(C_6H_5)_3.C_6H_6$ rhombs |
| 49.4 | 24.0 | 8.8 | " |
| 65.6 | 38.9 | 17.2 | " |
| 73.8 | 57.5 | 30.2 | " |
| 77.1 | 67.4 | 39.7 | " |
| 77.9 | 76.3 | 50.7 | " |
| 77.5 | 80.2 | 56.4 | " |
| 76.2 | 84.1 | 62.8 | " |
| 74.6 | 87.5 | 69.1 | $CH(C_6H_5)_3$ monoclinic |
| 76.0 | 89.0 | 72.2 | " |
| 78.8 | 90.5 | 75.3 | " |
| 82.3 | 93.1 | 81.3 | " |
| 86.6 | 95.7 | 87.8 | " |

Hartley and Thomas call attention to the inaccuracy of Linebarger's results and to the correctness of the determinations of Kuriloff (1897a). According to Kuriloff the tr. pt. $(C_6H_5)_3CH.C_6H_6 + C_6H_6$ is at 4.2° and 1.25 mol. % $(C_6H_5)_3CH$, the m. pt. of $(C_6H_5)_3CH.C_6H_6$ is 78.2° and the tr. pt. $(C_6H_5)_3CH.C_6H_6 + (C_6H_5)_3.CH$ is at 74° and 69.4 mol. % $(C_6H_5)_3CH$.

Freezing-point data are given for mixtures of Triphenyl Methane and:

Aniline(4)
Anthracene(9)
Biphenyl(9)
Dichlor benzene(7)
Dinitro phenol(3)
Hydroquinone(4)
Naphthalene(9)
Naphthols(4)
Naphthylamines(4)
Nitrophenols(4)
Phenol(4)
Phenylene diamines(3)(4)(10)
Picric acid(1)(4)(10)
Pyrocatechol(4)
Pyrogallol(4)
Quinone(5)
Resorcinol(4)
Sarcosine anhydride(8)
Styphnic acid(1)(2)
Toluidine(4)
Triphenyl carbinol(3)
" guanidine(6)

(1) Jefremow, 1918; (2) Jefremow, 1919a; (3) Kremann, Mauermann, Müller and Rösler, 1923; (4) Kremann, Odelga and Zawodsky, 1921; (5) Kremann, Sutter, Sitte, Strzelba and Dobotzky, 1922; (6) Lautz, 1913; (7) Morris and Cook, 1935; (8) Pfeiffer and Angern, 1926; (9) Vignon, 1891; (10) Rheinboldt and Kirscheisen, 1926.

$C_{19}H_{16}O_1$

**TRIPHENYL CARBINOL** $(C_6H_5)_3COH$.

100 gms. $C_6H_6$ dissolve 16.5 gms. $(C_6H_5)_3COH$ at 25°. (Halford, 1931.)

Freezing-point data are given for mixtures of Triphenyl Carbinol and:

Dinitro benzenes(1)
" phenols(2)
" toluene(1)
Hydroquinone(4)
Naphthalene(2)
Naphthols(4)
Naphthylamine(4)
Nitrophenols(1)
Phenol(4)
Phenylene diamine(1)
Picric acid(1)
Pyrocatechol(4)
Pyrogallol(1)
Quinone(3)
" + nitrophenol(3)
Resorcinol(4)
Toluidine(4)
Trinitro benzene(1)
Trinitro toluene(1)
Triphenyl methane(2)

(1) Kremann, Höhl and MüllerII, 1921; (2) Kremann, Mauermann, Müller II and Rösler, 1923; (3) Kremann, Sutter, Sitte, Strzlba and Dobotzky, 1922; (4) Kremann and Wlk, 1919.

α Tri Phenyl**GUANIDINE** $C_6H_5N:C(NHC_6H_5)_2$.

SOLUBILITY IN MIXTURES OF ALCOHOL AND WATER AT 25°. (Holleman and Antusch, '94.)

| Vol. % Alcohol. | Gms. $C_6H_5N:C(NHC_6H_5)_2$ per 100 Gms. Solvent. | Density of Solutions. | Vol. % Alcohol. | Gms. $C_6H_5N:C(NHC_6H_5)_2$ per 100 Gms. Solvent. | Density of Solutions. |
|---|---|---|---|---|---|
| 100 | 6.23 | 0.8021 | 80 | 1.06 | 0.8572 |
| 95 | 3.75 | 0.8158 | 75 | 0.67 | 0.8704 |
| 90 | 2.38 | 0.8309 | 70 | 0.48 | 0.8828 |
| 85 | 1.58 | 0.8433 | 60 | 0.22 | 0.9048 |

See remarks under α Acetnaphthalide, p. 705

Freezing-point lowering data are given by Lautz, 1913, for mixtures of triphenyl guanidine and each of the following compounds: acetamide, phthalide, and triphenyl methane.

**CINNAMYLIDENE BENZAL ACETONE** $C_6H_5CH:CH.CH:CHCOCH:CHC_6H_5$.

Freezing-point data are given for mixtures of cinnamylidene benzal acetone and diethyl barbuturic acid (veronal) by Pfeiffer and Angern, 1926.

**DIANISAL ACETONE** $(CH_3OC_6H_4CH:CH)_2CO$.

Freezing-point data are given for mixtures of dianisal acetone and:

Acenaphthene(2)
Benzoic acid(2)
Biphenyl(3)
Iodo biphenyl(3)
Naphthols(2)
Naphthylamine(2)
Nerolin(2)
Nitraniline(2)
Phenyl acetic acid(1)(2)
Resorcinol(2)

(1) Pfeiffer, 1924; (2) Pfeiffer, Goebel and Angern, 1925; (3) Pfeiffer, Schmitz and Inoue, 1929.

**THEBAINE** (Para Morphine) $C_{19}H_{21}NO_3$.

Solubility in Several Solvents.

| Solvent. | t°. | Gms. Thebaine per 100 Gms. Solvent. | Authority. |
|---|---|---|---|
| 92 Wt. % Alcohol | 25 | 0.1 | ... |
| Ether | 10 | 0.71 | ... |
| Aniline | 20 | 30 | (Scholtz, 1912.) |
| Pyridine | 20 | 9 | " |
| Piperidine | 20 | 2 | " |
| Diethylamine | 20 | 9.7 | |

100 gms. Olive Oil dissolve 0.8 gml thebaine at 25°. (Walton, 1935)

**THEBAINE** $C_{19}H_{21}NO_3$.

Solubility of Thebaine in Water. (Kolthoff, 1925.)

The dissociation constant was calculated, from colorimetric $p_H$ measurements in mixtures of 0.01 *n* thebain hydrochloride and 0.01 *n* Na OH solutions. to be $K = 9.10^{-7}$. For the determination of the solubility product it was found that a mixture of 5 cc. of a 0.01 *n* thebaine hydrochloride solution and 0.9 cc. of 0.01 *n* NaOH gave a slight crystalline deposit after 4 hours. The $p_H$ of the solution was 7.6. Calculating from this experiment, $L_{Thebaine} = 2.10^{-9}$. From this value and the dissociation constant, the solubility of thebaine in water was calculated to be $2.2.10^{-3}$ mols. or 0.685 gms. per liter at 15°.

**THEBAINE PICRATE** $C_{19}H_{21}NO_3.HOC_6H_2(NO_2)_3$.

100 gms. sat. sol. of Thebaine picrate in water contain 0.20 gm. of the salt at 20°.
" " " " " " abs. alcohol " 0.10 " " " " " "
" " " " " " acetone " 10.1 " " " " " "
(Maplethorpe and Evers, 1925.)

**CINCHONIDINE** $C_{19}H_{22}N_2O$.

Solubility in Water at 15°. (Kolthoff, 1925.)

In determining the solubility product it was found that 5 cc. of a 0.0086 normal cinchonidine sulfate solution + 1.2 cc. 0.01 normal Na OH just yielded a few crystals. The $p_H = 7.6$ and $p_{OH} = 6.6$, corresponding to $[OH'] = 2.5.10^{-7}$. $L_{Cinchonidine} = 1.38.10^{-9}$. The calculated solubility in water is $9.10^{-4}$ mols. or 0.265 gm. per liter.

A saturated solution of cinchonidine sulfate in water was found to have a concentration of 0.0324 normal or 1.286 gm. $(C_{19}H_{22}N_2O)_2.H_2SO_4.6\,H_2O$ per liter at 15°.

**CINCHONIDINE HELIANTHATE** $C_{19}H_{22}N_2O(C_{14}H_{15}N_3SO_3)$.

1000 cc. $H_2O$ dissolve 0.196 gm. of the salt at 20-25°. (Stark and Dehn, 1918.)

**CINCHONINE** $C_{19}H_{22}N_2O$.

Solubility in Water at 15°. (Kolthoff, 1925.)

In determining the solubility product it was found that 5.0 cc. of a 0.00975 molecular cinchonine sulfate solution + 0.2 cc. of 0.01 normal Na OH gave a precipitate only after long standing. With 0.3 cc. or 0.4 cc. of 0.01 *n* Na OH the precipitate appeared immediatcly. All the solutions had a $p_H$ of 6.0 or a $p_{OH}$ of 8.2, corresponding to $[OH'] = 6.4.10^{-9}$. The calculated solubility product, $L_{Chinchonine} = 6.10^{-11}$. Calculating from this and the first dissociation constant $K_1 = 1.4.10^{-6}$, the solubility of cinchonine in water is $4.8.10^{-6}$ mols. or 0.0144 gm. per liter.

A saturated solution of **Cinchonine Sulfate** in water was found to have a concentration of 0.039 normal or 1.41 gm. $(C_{19}H_{22}N_2O)_2.H_2SO_4.2\,H_2O$ per liter at 18°. The saturated solution had a $p_H$ of 5.8 and first dissociation constant $K_1 = 1.4.10^{-6}$ and second dissociation constant $K_2 = 1.2.10^{-10}$.

SOLUBILITY OF CINCHONINE, CINCHONIDINE, QUININE, AND QUINIDINE IN SEVERAL SOLVENTS. (Müller, 1903; see also Prunier, 1879.)

| Solvent. | Grams of the Alkaloid per 100 Grams Solution. | | | | |
|---|---|---|---|---|---|
| | Cinchonine $C_{19}H_{22}N_2O$. | Cinchonidine $C_{19}H_{22}N_2O$. | Quinine $C_{20}H_{24}N_2O_2$. | | Quinidine $C_{20}H_{24}N_2O_2$. |
| | | | Hydrate. | Anhydride. | |
| Ether | 0.10 | 0.211 | 1.619 | 0.876 | 0.776 |
| Ether sat. with $H_2O$ | 0.123 | 0.523 | 5.618 | 2.794 | 1.629 |
| $H_2O$ sat. with Ether | 0.025 | 0.0306 | 0.0667 | 0.0847 | 0.031 |
| Benzene | 0.0545 | 0.099 | 0.2054 | 1.700 | 2.451 |
| Chloroform | 0.6979 | 9.301 | 100+ | 100+ | 100+ |
| Acetic Ether | 0.0719 | 0.3003 | 4.65 | 2.469 | 1.761 |
| Petroleum Ether | 0.0335 | 0.0475 | 0.0103 | 0.0211 | 0.0241 |
| Carbon Tetra Chloride | 0.0361 | 0.0508 | 0.203 | 0.529 | 0.565 |
| Water | 0.0239 | 0.0255 | 0.574 | 0.0506 | 0.0202 |
| Glycerine (15.5°) | 0.50 | | 0.50 | ... | ... |

SOLUBILITY OF CINCHONINE AND CINCHONIDINE IN SEVERAL SOLVENTS.

| Solvent. | t°. | Gms. Alkaloid per 100 Gms. Solvent. | | Authority. |
|---|---|---|---|---|
| | | Cinchonine. | Cinchonidine. | |
| Water | ord. temp. | 0.0043 | ... | (Hatcher, 1902.) |
| " | 20 | 0.0131 | ... | (Scholtz, 1912.) |
| " | 25 | 0.0113 | 0.021 | (Schaefer, 1910.) |
| Aq. 10% Ammonia | 20 | 0.025 | ... | (Scholtz, 1912.) |
| Aq. 85% $C_2H_5OH$+10% Am. | 20 | 0.41 | ... | " |
| Aniline | 20 | 1.6 | ... | " |
| Pyridine | 20 | 1.4 | 7.78 | (Scholtz, 1912; Dehn, 1917.) |
| 50% Aq. Pyridine | 20–25 | ... | 10 | (Dehn, 1917.) |
| Aq. 85% $C_2H_5OH$ ($d_{20}$=0.832) | 20 | 0.86 | ... | (Scholtz, 1912.) |
| $C_2H_5OH$ (95%) | 20 | 0.80 | 5 | (Wherry and Yanovsky, 1918.) |
| $C_2H_5OH$ (prob. 92.3 wt. %) | 25 | 0.62 | 5.1 | (Schaefer, 1913.) |
| Abs. $C_2H_5OH$ | 19 | 0.874 | ... | (Timofeiew, 1894.) |
| Abs. $C_2H_5OH$ | 25 | 0.89 | ... | (Sill, 1905.) |
| Benzene | 25 | 0.057 | 0.127 | (Schaefer, 1913.) |
| Acetone | 25 | 0.091 | ... | (Sill, 1905.) |
| Chloroform | 17 | 0.014 | ... | (Oudemans, 1872.) |
| " | 25 | 0.606 | 19 | (Schaefer, 1913.) |
| " | 50 | 0.565 | ... | (Köhler, 1879.) |
| Ether | 25 | 0.055 | ... | (Sill, 1905.) |
| " | 32 | 0.264 | ... | (Köhler, 1879.) |
| Isoamyl Alcohol | 25 | 1.10 | ... | (Sill, 1905.) |
| Isobutyl Alcohol | 19 | 1.09 | ... | (Timofeiew, 1894.) |
| Methyl Alcohol | 25 | 0.785–1.17 | 7.39 | (Schaefer, 1913; Sill, 1905.) |
| Piperidine | 20 | 3.5 | ... | (Scholtz, 1912.) |
| Diethyl Amine | 20 | 1.3 | ... | " |

Results for the solubility of cinchonine and cinchonidine in mixtures of ethyl and methyl alcohols with benzene and with chloroform are given by Schaefer (1913).

It is pointed out by Schaefer (1910), that if the saturated solution is analyzed by shaking out with chloroform or ether, variable results, depending on the age and method of manufacture of the alkaloid, will be obtained.

Except in the case of the results by Sill in the above table, the saturated solutions were obtained by agitating at intervals, instead of constantly at the given temperature.

## CINCHONA ALKALOIDS

### Solubility of Cinchonine, Cinchonidine and Cinchotine Salts in Water.

| Salt. | t°. | Gms. per 100 Gms. $H_2O$. Cinchonine Salt. | Cinchonidine Salt. | Cinchotine Salt. | Authority. |
|---|---|---|---|---|---|
| Hydrobromide | 25 | 1.7 | 1.66 | ... | (Schaefer, 1910.) |
| Bihydrobromide | 25 | 55.5 | 14.3 | ... | " |
| Hydrochloride | 25 | 4.5[1] | 4.8[2] | 2.12[3] | (Schaefer, 1910; Forst and Böhringer, 1881.) |
| Bihydrochloride | 25 | ... | 62.5 | ... | (Schaefer, 1910.) |
| Sulfate | 25 | 1.17[4] | 1.08[5] | 3.28[6] | (Schaefer, 1910; Forst and Böhringer, 1881.) |
| Sulfate | 80 | 3.1 | 4.8 | ... | (U. S. P.) |
| Bisulfate | 25 | 66.6 | 100 | ... | (Schaefer, 1910.) |
| Perchlorate | 12 | 0.3(solvent = aq. 6% $HClO_4$) | | | (Hofmann, Roth, Höbold and Metzler, 1910.) |
| Salicylate | 25 | 0.17 | 0.075 | ... | (Schaefer, 1910.) |
| Tannate | 25 | 0.091 | 0.055 | ... | " |
| Tartrate | 25 | 3.12[7] | ... | 1.76[8] | (Schaefer, 1910; Forst and Böhringer, 1881.) |
| Bitartrate | 16 | 0.99 | ... | 1.28 | (Forst and Böhringer, 1881.) |
| Oxalate | 20 | 0.96 | ... | 1.16 | " " |

[1] 4.16 at 10°. [2] 4 at 15°. [3] at 10°. [4] 1.52 at 13°. [5] 1 at 15°. [6] at 13°. [7] 3 at 16°. [8] at 16°.

### Solubility of Cinchonine Sulfate and of Cinchonidine Sulfate in Alcohol and Other Solvents.

| Solvent. | t°. | Gms. per 100 Gms. Solvent. $(C_{19}H_{22}N_2O)_2 \cdot H_2SO_4 \cdot 2H_2O$. | $(C_{19}H_{22}N_2O)_2 \cdot H_2SO_4 \cdot 3H_2O$. | Authority. |
|---|---|---|---|---|
| Ethyl Alcohol (92.3 wt. %) | 25 | 9.8 (10) | 0.85 (1.4) | (Schaefer, 1913; U. S. P.) |
| " " " | 60 | ... (19.2) | ... (3.1) | (U. S. P.) |
| Methyl Alcohol | 25 | 83.9 | 35.9 | (Schaefer, 1913; U. S. P.) |
| Chloroform | 25 | 0.66 (1.45) | 0.1 (0.11) | (Schaefer, 1913; U. S. P.) |
| Ether | 25 | 0.04 | 0.02 | (U. S. P.) |
| Glycerol | 15 | 6.7 | | |

Results for mixtures of alcohol, chloroform and benzene are given by Schaefer, '13.

Very carefully determined data for the solubility of *Cinchonine* in ethyl alcohol, methyl alcohol, amyl alcohol and acetone solutions of various concentrations of a large number of organic acids and of phenols are given by Sill, 1905.

### Solubility of Cinchonine Sulfate in Chloroform Containing Increasing Amounts of Ethyl Alcohol.

(Hatcher, 1934.)

An excess of cinchonine sulfate was added to the solvents and the mixtures shaken from time to time at room temperature (20°?) for 24 hours. The dissolved cinchonine sulfate was determined by evaporation and weighing.

| Gms. $C_2H_5OH$ per 100 gms. solvent | $d_{25}$ of solvent | Gms. cinchonine sulfate per 100 gms. solvent |
|---|---|---|
| trace | 1.4862 | 0.114 |
| 0.15 | 1.4841 | 0.212 |
| 0.5 | 1.4797 | 0.89 |
| 1.0 | 1.4732 | 2.11 |
| 2.16 | 1.4583 | 4.89 |

**CUPREINE SULFATE.** $C_{19}H_{20}N_2(OH)_2 \cdot H_2SO_4$.

A sample twice recrystallized from $H_2O$ gave a solubility of $1.855.10^{-3}$ normal or 0.666 gm. anhydrous cupreine sulfate per liter at 18°. The sat. solution had a $p_H$ of 5.8. The dissociation constant was $K_1 = 2.7.10^{-7}$. (Kolthoff, 1925.)

**PHENYL HYDRAZINE HELIANTHATE** $C_5H_8N_2.C_{14}H_{15}N_3SO_2$.

1000 cc. $H_2O$ dissolve 0.135 gm. phenyl hydrazine helianthate at 20-25°.
(Stark and Dehn, 1918.)

**DIONINE** (Ethyl Morphine) $C_{19}H_{23}NO_3$.

100 cc. $H_2O$ dissolve 0.2613 gm. $C_{19}H_{23}NO_3$ at 20° (Zalai, 1910.)
100 cc. oil of sesame dissolve 0.5144 gm. $C_{19}H_{23}NO_3$ at 20°. "

100 cc. $H_2O$ dissolve 0.208 gm. $C_{17}H_{17}OH(OH)(OC_2H_5)$ at 25°. (Schaeffer, 1912.)
" alcohol " 1.33 gms. " " "
" ether " 66.6 " " " "

Ethyl **MORPHINE HYDROCHLORIDE** $C_{17}H_{17}NO(OH)(OC_2H_5).HCl.2H_2O$
(Dionin)

Solubility in Water and in Alcohol. (Schaeffer, 1912.)

| t°. | Gms. Ethyl Morphine HCl per 100 cc. Water. | Alcohol. |
|---|---|---|
| 15 | 8.7 | 3.85 |
| 25 | 12.5 | 5 |
| 40 | 25 | 12.1 |
| 50 | 40 | 20 |

These results differ from similar data for commercial samples of Dionin.
The differences are believed to be due to the impurities (amorphous salts of the by-products of the ethylation) in commercial products.
100 cc. $H_2O$ dissolve 10 gms. ethyl morphine hydrochloride at ord. temp. (Dott, 1912.)

**MONOTROPITOSIDE** $C_{19}H_{26}O_{12}.H_2O$.

Solubility of Monotropitoside in Several Solvents at 18-20°.
(Bridel and Picard, 1926.)

This compound is the glucoside which generates methyl salicylate and is formed by the union of 1 mol. of methyl salicylate, 1 mol. of glucose and 1 mol. of xylose, with elimination of 2 mols of water.

| Solvent. | Gms. $C_{19}H_{26}O_{12}$ per 100 gms. solvent. | Solvent. | Gms. $C_{19}H_{26}O_{12}$ per 100 gms. solvent. |
|---|---|---|---|
| Water | 8.09 | Anhydrous ethyl acetate | 0.172 |
| 95 % alcohol | 0.665 | » acetone | 0.154 |
| Abs. alcohol | 0.344 | » ethyl ether | 0.018 |
| Chloroform | 0.100 | | |

**METHYL STEARATE** $CH_3(CH_2)_{16}COOCH_3$.

Freezing-point data for mixtures of methyl stearate and methyl palmitate are given by Guy and Smith, 1939.

**ETHYL MARGARATE** $CH_3(CH_2)_{15}COOC_2H_5$.

Freezing-point data are given by Carey and Smith, 1933, for mixtures of ethyl margarate with ethyl palmitate and with ethyl stearate.

**IODOEOSIN** (Sodium tetra iodofluorescein) $C_{20}H_6I_4O_5Na_2$.

100 gms. $H_2O$ dissolve 90 gms. iodoeosin at 20–25°. (Dehn, 1917.)
100 gms. pyridine dissolve 4.63 gms. iodoeosin at 20–25°. "
100 gms. aq. 50% pyridine dissolve 71.6 gms. iodoeosin at 20–25°. "

**FLUORESCEIN** $C_{20}H_{12}O_5$.

100 gms. $H_2O$ dissolve 0.005 gm. fluorescein at 20–25° (Dehn, 1917.)
100 gms. pyridine dissolve 13.29 gms. fluorescein at 20–25° "
100 gms. aq. 50% pyridine dissolve 37.22 gms. fluorescein at 20–25° "

**PONCEAU** (Free Acid) $C_{10}H_7N{:}N.C_{10}H_4(OH)(SO_3H)_2.9H_2O$.

SOLUBILITY IN SEVERAL SOLVENTS AT 23.° (Sisley, 1902.)

| Solvent. | Gms. Ponceau per Liter. |
|---|---|
| Water | 209.6 |
| " +5 Gms. $H_2SO_4$ per Liter | 180 |
| " Sat. with Amyl Alcohol | 195 |
| Amyl Alcohol | 73.4 |
| Ether, pure | none |

Data are also given for the distribution of ponceau between water and amyl alcohol at 18°.

**PHENOLPHTHALEIN** $(C_6H_4OH)_2CO.C_6H_4CO$.

100 gms. $H_2O$ dissolve 0.0175 gm. phenolphthalein at 20°. (Acree and Slagle, 1909.)
" " " 0.04 " " at 20–25°. (Dehn, '17.)
" Pyridine " 796. gms. " " " "
" aq. 50% pyridine " 300 " " " "

**PHENOL PHTHALEIN** $(OHC_6H_4)_2CO.C_6H_4CO$.

SOLUBILITY OF PHENOLPHTHALEIN IN SEVERAL SOLVENTS AT 15°-20°. (?) (Utz, 1920.)

| Solvent. | Gms. $C_{20}H_{14}O_4$ per 100 gms. solvent. | Solvent. | Gms. $C_{20}H_{14}O_4$ per 100 gms. solvent. | Solvent. | Gms. $C_{20}H_{14}O_4$ per 100 gms. solvent. |
|---|---|---|---|---|---|
| Water | 0.0002 | Chloroform | 3.06 | Carbon tetrachloride. | trace |
| Ethyl alcohol | 20.91 | Carbon disulfide. | 0.18 | Xylene | 0.18 |
| Methyl alcohol | 14.18 | Ether | 5.92 | Toluene | 0.61 |
| Acetone | 26.39 | Benzene | 0.16 | Nitrobenzene | 4.41 |
| | | | | Ethyl acetate | 6.57 |

100 gms. abs. alcohol dissolve 10.24 gms. $C_{20}H_{14}O_4$ at 20°–25°.
" quinoline " 0.32 " "
" equi. mol. mixture of alcohol and quinoline dissolve 0.19 gm. $C_{20}H_{14}O_4$ at 20°–25°. (Pucher and Dehn, 1921.)

100 gms. Pet. Ether dissolve 0.017 gm. phenol phthalene at 25°. (Warren, 1933.)

**NITRON** $C_{20}H_{16}N_4$.

100 gms. carbon tetrachloride dissolve 2.55 gms. nitron at 20° (Pawlewski, 1914, 1926.)
" chloroform " 0.03 " "

**NITRON NITRATE** $C_{20}H_{16}N_4.HNO_3$.

SOLUBILITY OF NITRON NITRATE IN AQUEOUS SOLUTIONS OF NITRIC ACID AT 25°. (Drucker, 1929.)

| Gm. Equiv. $HNO_3$ per liter | Gms. $C_{20}H_{16}N_4.HNO_3$ per liter | Gm. Equiv. $HNO_3$ per liter | Gms. $C_{20}H_{16}N_4.HNO_3$ per liter |
|---|---|---|---|
| 0.000 | 0.4155 | 0.02449 | 0.0923 |
| 0.00761 | 0.1509 | 0.04790 | 0.0755 |
| 0.01327 | 0.1185 | 0.08763 | 0.0569 |

## 5-PHENYL-10-METHYL ACRIDIUM HYDROXIDE $(C_6H_4)_2C(OH)(C_6H_5)N(CH_3)$.

SOLUBILITY OF 5-PHENYL-10-METHYL ACRIDIUM HYDROXIDE IN AQUEOUS SALT SOLUTIONS AT 25°.
(Aston and Montgomery, 1931.)

| Aqueous Solution of: | Gm. Mols. per 1000 gms. Solution: Salt | $C_{20}H_{16}NOH$ | Aqueous Solution of: | Gm. Mols. per 1000 gms. solution: Salt | $C_{20}H_{16}NOH$ |
|---|---|---|---|---|---|
| $H_2O$ alone | 0.0 | 0.000083 | KCl | 0.0388 | 0.000097 |
| $BaCl_2$ | 0.00296 | 0.000096 | " | 0.0399 | 0.000110 |
| " | 0.0444 | 0.000116 | " | 0.0675 | 0.000106 |
| $NH_4Cl$ | 0.0193 | 0.000234 | " | 0.0739 | 0.000115 |
| " | 0.0187 | 0.000231 | " | 0.138 | 0.000129 |
| | | | " | 0.141 | 0.000141 |

## TRIPHENYL ACETIC ACID $C(C_6H_5)_3COOH$.

SOLUBILITY OF TRIPHENYL ACETIC ACID IN AQUEOUS SOLUTIONS OF ACETIC ACID AT 25°.
(Dittmar, 1929.)

| Normality of aq. $CH_3COOH$ | Gms. $C(C_6H_5)_3COOH$ per 100 cc solution | Normality of aq. $CH_3COOH$ | Gms. $C(C_6H_5)_3COOH$ per 100cc solution |
|---|---|---|---|
| 0.000 | 0.0050 | 8.824 | 0.0090 |
| 1.529 | 0.0045 | 10.912 | 0.0305 |
| 2.875 | 0.0060 | 11.661 | 0.0440 |
| 4.590 | 0.0045 | 14.433 | 0.1500 |
| 5.923 | 0.0100 | 17.365 | 0.6105 |

## ROSOLIC ACID $C_{20}H_{16}O_3$.

100 gms. $H_2O$ dissolve 0.12 gm. $C_{20}H_{16}O_3$ at 20°–25°. (Dehn, 1917.)
100 gms. pyridine dissolve 160 gm. $C_{20}H_{16}O_3$ at 20°–25°. "
100 gms. aq. 50% pyridine dissolve 80 gm. $C_{20}H_{16}O_3$ at 20°–25°. "

## DIBENZOYL METHYL TARTRATE $(CHOCOC_6H_5CO_2CH_3)_2$.

Freezing-point data for mixtures of the d and r compound are given by Findlay and Campbell, 1928.

## ROSANILINE $C_{20}H_{21}N_3O$.

100 gms. $H_2O$ dissolve 0.03 gm. $C_{20}H_{21}N_3O_4$ at 20°–25°. (Dehn, 1917.)
100 gms. pyridine dissolve 41.5 gms. $C_{20}H_{21}N_3O_4$ at 20°–25°. "
100 gms. aq. 50% pyridine dissolve 35.1 gms. $C_{20}H_{21}N_3O_4$ at 20°–25°. "

## Triphenyl *p* ROSANILINE HYDROCHLORIDE $(C_6H_4.NH.C_6H_5)_3C(OH).HCl$.

SOLUBILITY IN SEVERAL SOLVENTS AT 23°.
(v. Szathmary de Szachmar, 1910.)

| Solvent. | Gms. Triphenyl *p* Rosaniline HCl per 100 Gms. Sat. Sol. |
|---|---|
| Methyl Alcohol | 0.447 |
| Ethyl " | 0.285 |
| Amyl " | 0.11 |
| Acetone | 0.19 |
| Aniline | 0.518 |

**PAPAVERINE** $C_{20}H_{21}NO_4$.

100 gms. carbon tetrachloride dissolve 0.203 gm. at 17°. (Schindelmeiser, 1901.)
100 gms. carbon tetrachloride dissolve 0.518 gm. at 20°. (Gori, 1913.)
100 gms. ethyl ether dissolve 0.38 gm. at 10°.
100 gms. of each of the following solvents dissolve the stated amount of papaverine at 20°. Aniline, 29 gms.; pyridine, 8 gms.; piperidine, 1 gm.; diethylamine, 0.4 gm. (Scholtz, 1912.)

100 gms. quinoline dissolve 7.66 gms. papaverine at 20-25°.
(Pucher and Dehn, 1921.)

**PAPAVERINE PICRATE** $C_{20}H_{21}NO_4.OH.C_6H_2(NO_2)_3$.

100 gms. sat. sol. of papaverine picrate in water contain 0.007 gm. of the cmpd at 20°.
» » » » » acetone » 1.81 » » »
» » » » »abs. alcohol» 0.052 » » »
(Maplethorpe and Evers, 1925.)

**HELIANTHINE PHENOLATE** $C_{14}H_{15}N_3SO_3.C_6H_5OH$.

1000 cc. $H_2O$ dissolve 0.157 gm. helianthine phenolate at 20-25°. (Stark and Dehn, 1918.

**NARCOTINE** $C_{20}H_{23}NO_7$.

Solubility in Several Solvents.

| Solvent. | t°. | Gms. Narcotine per 100 Gms. Solvent. | Authority. |
|---|---|---|---|
| Water | 15 | 0.1* | (Guerin, 1913.) |
| Water | 20 | 0.00445 | (Zalai, 1910.) |
| Acetone | 15 | 41.96* | (Guerin, 1913.) |
| Aq. 50 Vol. % Acetone | 15 | 0.7* | " |
| Aniline | 20 | 25 | (Scholtz, 1912.) |
| Pyridine | 20 | 2.3 | " |
| Piperidine | 20 | 1.7 | " |
| Diethylamine | 20 | 0.4 | " |
| Carbon Tetrachloride | 20 | 1.04 | (Gori, 1913.) |
| Trichlor Ethylene | 15 | 6.5 | (Wester and Bruins, 1914.) |
| Oil of Sesame | 20 | 0.086 | (Zalai, 1910.) |

* Per 100 cc. solvent.

100 gms. $C_6H_6$ dissolve 4.5 gm. narcotine at 25°. (Warren, 1935.)
100 gms. Pet. Ether dissolve 0.023 gm. narcotine at 25°. (Warren, 1935.)

**PHENACYL ARACHIDATE** $CH_3(CH_2)_{18}COO.CH_2COC_6H_5$.

Solubility of Phenacyl, Bromophenacyl and Chlorophenacyl Arachidate in 95 % Ethyl Alcohol.
(Hann, Reid and Jameson, 1930.)

| Arachidate | Formula | Gms. arachidate per 100cc 95% alcohol at: 20° | 25° |
|---|---|---|---|
| Phenacyl arachidate | $CH_3(CH_2)_{18}COOCH_2COC_6H_5$ | 0.1348 | 0.2660 |
| p Bromo Phenacyl arachidate | $CH_3(CH_2)_{18}COOCH_2COC_6H_4Br$ | 0.0080 | 0.0106 |
| p Chloro " " | $CH_3(CH_2)_{18}COOCH_2COC_6H_4Cl$ | 0.0100 | 0.0125 |

## QUININE $C_{20}H_{24}N_2O_2.3\,H_2O$.

### Solubility of Quinine in Water at 15°. (Kolthoff, 1925.)

The *dissociation constants* as estimated by the colorimetric titration curve, using 0.01 mol. quinine hydrochloride and 0.01 *n* Na OH, also by means of the quinhydrone electrode, were found to be $K_1 = 1\ 08.10^{-6}$ and $K_2 = 2.10^{-10}$ at 15°.

The *solubility product* calculated from a precipitation experiment made by adding just enough of 0.01 *n* Na OH (1.6 to 1.8 cc.) to 5 cc. of 0.05 molecular quinine .H Cl to give a trace of opalescence, was found to be, $L_{quinine} = 4.4.10^{-9}$. From this and the $K_1$ dissociation constant the solubility of quinine in water was calculated to be $4.05.10^{-3}$ gms. mols. per liter. From another experiment in which 0.01 mol. quinine .HCl was used instead of 0.05 mol., a value of $2.10^{-9}$, corresponding to a solubility of $1.9.10^{-3}$ mol. per liter was found. Even this value is, however, too high according to the experiments of Mauz (Dissertation, Stuttgart) who found a saturated solution of quinine in water at 18° to have a concentration of $6.10^{-4}$ mol. per liter. Other experiments with quinine containing .3 $H_2O$ of crystallization gave $6.55.10^{-4}$ mol. per liter. From these and the first dissociation constant it is evident that the *true* solubility of quinine is about $7.10^{-10}$ mol. per liter.

### Distribution of Quinine Between Water and Ethyl Ether at 0°. (Treadwell, 1923.)

To 100 cc. of purified ether + 100 cc. of $CO_2$ free water, different amounts of purified quinine were added and the mixtures shaken in melting ice for one hour. After separation of the two layers 25 cc. portions of the aqueous layers were conductometrically titrated with 0.005 *n* H Cl.

| Gms. Quinine per 100 cc. | | | Gms. Quinine per 100 cc. | | |
|---|---|---|---|---|---|
| $H_2O$ layer. $C_2$. | Ethereal layer. $C_1$. | $\frac{C_1}{\sqrt{C_2}}$. | $H_2O$ layer. $C_2$. | Ethereal layer. $C_1$. | $\frac{C_1}{\sqrt{C_2}}$. |
| 0.5611 | 0.0390 | 0.0520 | 1.1142 | 0.0547 | 0.0518 |
| 0.6274 | 0.0410 | 0.0410 | 1.2378 | 0.0577 | 0.0518 |
| 0.7074 | 0.0435 | 0.0517 | 1.2901 | 0.0590 | 0.0519 |
| 0.9013 | 0.0491 | 0.0516 | 1.3457 | 0.0603 | 0.0520 |
| 0.9083 | 0.0492 | 0.0517 | 1.4281 | 0.0622 | 0.0520 |
| 1.0018 | 0.0519 | 0.0518 | 1.5387 | 0.0647 | 0.0522 |

The observed $C_1$ values were plotted on a large scale diagram and the above results read by the author from the curve. The constancy of the ratio $\frac{C_1}{\sqrt{C_2}}$ shows that quinine exists in the ethereal layer in double the size molecules that it has in the $H_2O$ layer.

100 cc. sat. solution of quinine in pure acetone contain 2.32 gms. of the alkaloid at 15°. (Harvey and Back, 1921.)

100 gms Alcohol (Abs.) dissolve 166.6 gms. Quinine at 20-25°.

100 gms. Quinoline dissolve 22.28 gms. Quinine at 20-25. (Pucher and Dehn, 1921.)

100 gms. Equimol. mixture of Alcohol and Quinoline dissolve 30.04 gms. Quinine at 20-25°. (Pucher and Dehn 1921.)

100 gms. 86.5 % Glycerol ($d = 1.2326$) dissolve 0.33 gms. Quinine at 20°.
» 98.5 » ($d = 1.2645$) » 0.96 » »

## Hydro QUININE (Holm. 1921, 1922.)

### Solubility of Hydroquinine in Water at 15°. (Kolthoff, 1925.)

The *dissociation constant* was found to be $K_1 = 4.7.10^{-6}$. In determining the *solubility product* it was found that 10 cc. of 0.005 molecular hydroquinine H Cl + 0.1 cc. 0.1 *n* Na OH gave a trace of crystals. The $p_H = 8.3$ and the $p_{OH} = 5.9$. From this $L_{Hydroquinine} = 4.10^{-3} \times 1.25.10^{-6} = 5.10^{-9}$. From $K_1$ and L the solubility in water was calculated to be about 0.29 gm. hydroquinine per liter.

## Solubility of Quinine in Aqueous Solutions of Caustic Alkalies.

(Doumer and Deraux, 1895.)

Method. — A one per cent solution of quinine sulfate, containing a very small amount of HCl, was gradually added to 200 cc. portions of the caustic alkali solutions of the various concentrations stated, and the point noted at which a precipitate of the appearance corresponding to that of 1 cc. of milk in 100 cc. of water, remained undissolved.

| In Aq. Ammonia. | | In Aq. Sodium Hydroxide. | | In Aq. Pot. Hydroxide. | |
|---|---|---|---|---|---|
| Gms. $NH_3$ per 200 cc. Solution. | Gms. Anhydrous Quinine Dissolved. | Gms. NaOH per 200 cc. Solution. | Gms. Anhydrous Quinine Dissolved. | Gms. KOH per 200 cc. Solution. | Gms. Anhydrous Quinine Dissolved. |
| 0.52 | 0.084 | 0.007 | 0.092 | 0.612 | 0.088 |
| 0.65 | 0.084 | 0.012 | 0.091 | 1.512 | 0.082 |
| 4.59 | 0.096 | 0.740 | 0.090 | 3.456 | 0.068 |
| 13.08 | 0.122 | 2.160 | 0.079 | 10.944 | 0.039 |
| 18.88 | 0.144 | 3.188 | 0.056 | 44.704 | 0.006 |
| 25.19 | 0.174 | 6.172 | 0.044 | | |
| 35.79 | 0.184 | 8.537 | 0.021 | | |
| | | 17.074 | 0.015 | | |

## Solubility of Quinine in Several Solvents.

| Solvent. | t°. | Anhydrous Quinine Gms. per 100. Gms. Solvent. | Anhydrous Quinine Gms. per 100. cc. Solvent. | Hydrated Quinine Gms. per 100 Gms. Solvent. | Authority. |
|---|---|---|---|---|---|
| Water | 18–22 | 0.051 | ... | 0.0574 | (Müller, 1903.) |
| " | 25 | 0.057 | 0.033 | 0.065 | (U. S. P.; Schaefer, 1910.) |
| " | 80 | 0.123 | ... | 0.129 | (U. S. P.) |
| Ethyl Alcohol | 20 | 100 | ... | ... | (Wherry and Yanovsky, 1918.) |
| " " | 25 | 166.6 | ... | 166.6 | (U. S. P.) |
| " " | 25 | ... | 1333 | ... | (Schaefer, 1913.) |
| Methyl Alcohol | 20 | ... | 66.6 | ... | " |
| Benzene | 25 | ... | 0.55 | 0.205 | (Schaefer; Müller, 1903.) |
| " | 20 | 0.5 | ... | ... | (Wherry and Yanovsky, 1918.) |
| " | 18–22 | 1.7 | ... | ... | (Müller, 1903.) |
| Aniline | 20 | 14.5 | ... | ... | (Scholtz, 1912.) |
| Carbon Tetrachloride | 20 | 0.54 | ... | 0.204 | (Gori, 1913; Müller, 1903.) |
| Chloroform | 25 | 50–52.6 | ... | 62.5 | (Schaefer, 1913; U. S. P.) |
| " | 18–22 | 100+ | ... | 100+ | (Müller, 1903.) |
| Diethylamine | 20 | 57 | ... | ... | (Scholtz, 1912.) |
| Ether | 25 | 22.2 | ... | 76.9 | (U. S. P.) |
| " ($d=0.72$) | 18–22 | 0.876 | ... | 1.62 | (Müller, 1903.) |
| " sat. with $H_2O$ | 18–22 | 2.8 | ... | 5.62 | " |
| $H_2O$ sat. with Ether | 18–22 | 0.085 | ... | 0.067 | " |
| Ethyl Acetate | 18–22 | 24.7 | ... | 4.65 | |
| Petroleum Ether (b. pt. 59°–64°) | 18–28 | 0.021 | ... | 0.010 | " |
| Oil of Sesame | 20 | ... | 0.0453 | 0.053 | (Zalai, 1910.) |
| Glycerol | 25 | 0.633 | ... | 0.472 | (U. S. P.; Ossendowski, 1907.) |
| Piperidine | 20 | 119 | ... | ... | (Scholtz, 1912.) |
| Pyridine | 20 | 101 | ... | ... | " |
| Aq. 50% Pyridine | 20–25 | 59.4 | ... | ... | (Dehn, 1917.) |
| 7.65 gms. $H_3BO_3$ per 100 cc. aq. 50% Glycerol | room temp. | 20 | ... | ... | (Baroni and Barlinetto, 1911.) |
| 15.3 gms. $H_3BO_3$ per 100 cc. aq. 50% Glycerol | room temp. | 40 | ... | ... | " |

## Solubility of Quinine in Benzene, Determined by the Synthetic (Sealed Tube) Method.

(van Iterson-Rotgans, 1914.)

| t°. | Wt. % Quinine. | Solid Phase. | t°. | Wt. % Quinine. | Solid Phase. | t°. | Wt. % Quinine. | Solid Phase. |
|---|---|---|---|---|---|---|---|---|
| 5.4 | 0 | $C_6H_6$ | 53–5 | 4.81 | | 137 | 80 | $C_{20}H_{24}N_2O_2$ |
| 5.3* | ... | " + | 63 | 6.09 | Mixed phase, | 142 | 83.04 | " |
| 17 | 0.72 | $C_{20}H_{24}N_2O_2.C_6H_6$ | 91 | 30.01 | probably a | 146 | 85.26 | " |
| 29 | 1.48 | " | 102 | 43.4 | colloid or sol- | 152 | 87.44 | " |
| 38.5 | 2.36 | " | 104.5 | 45.9 | ution of high | 158.5 | 91.4 | " |
| 49 | 5.22 | " unstable | 109 | 51.8 | viscosity. | 166 | 95.02 | " |
| ±70 | 28.9 | " " | 130 | 75.46 | | 174.7 | 100 | " |

* Eutec.

Freezing-point data are given for mixtures of Quinine and:

| | | |
|---|---|---|
| Acetanilide(4) | Menthol(1)(3) | Salol(1)(3) |
| Antipyrine(1)(3) | Phenacetine(1)(3) | Urea(1)(3) |
| " + Phenacetine(2) | " + Antipyrine(2) | Urethan(3) |

(1) Adamanis, 1933; (2) Hrynakowski, 1934; (3) Hrynakowski and Adamanis, 1933; (4) Hrynakowski and Adamanis, 1933a.

## Solubility of Quinine Salts in Water.

(Regnault and Willejean, 1887.)

| Salt. | t°. | Gms. Salt per 100 Gms. $H_2O$. | Salt. | t°. | Gms. Salt per 100 Gms. $H_2O$. |
|---|---|---|---|---|---|
| Brom Hydrate (basic) | 14 | 2.06 | Salicylate (basic) | 15 | 0.114 |
| " (neutral) | 12 | 12.33 | Sulfate " | 14 | 0.139 |
| " " | 14 | 13.19 | " " | 16 | 0.153 |
| " " | 16 | 14.79 | " " | 18 | 0.160 |
| " " | 15 | 14.20 | " (neutral) | 15 | 8.50 |
| Chlor Hydrate (basic) | 12 | 3.80 | " " | 17 | 8.90 |
| " " | 14 | 4.14 | " " | 18 | 9.62 |
| " " | 15 | 4.25 | Valerate (basic) | 12–16 | 2.59 |
| Lactate (basic) | 15 | 10.03 | | | |
| " " | 37 | 16.18 | | | |

## Solubility of Quinine Salts in Water at 25°.

(Schaefer, 1910.)

| Salt. | Gms. Salt per 100 Gms. $H_2O$. | Salt. | Gms. Salt per 100 Gms. $H_2O$. |
|---|---|---|---|
| Acetate | 2 | Hypophosphite | 2.85 |
| Anisol | 0.042 | Lactate, basic | 16.6 |
| Arsenate | 0.154 | Nitrate | 1.43 |
| Benzoate | 0.278 | Oxalate | 0.071 |
| Bihydrobromide | 20 | Phosphate | 0.125 |
| Bihydrochloride | 143 (133) | Picrate | 0.029 |
| Bihydrochloride + Urea | 100 | Quinate | 28.6 |
| Bisulfate | 11.78 | Salicylate | 0.048 |
| Chlorhydrosulfate | 77 (50) | Sulfate | 0.143 |
| Chromate | 0.032 | Bisulfoguiacolate | 200 |
| Citrate | 0.121 (0.083) | Sulfophenate | 0.4 |
| Glycerophosphate, basic | 0.1178 (insol.) | Urate | 0.182 |
| Hydrobromide | 2.33 | Phenylsulfate | 0.147 |
| Hydrochloride | 4.76 | Tartrate | 0.105 |
| Hydroferrocyanide | 0.05 | Tannate | 0.05(*) |
| Hydroiodide | 0.49 | Valerate | 1.25 |

* Insol.

It is pointed out that different values for the solubility may be obtained depending on the method used for preparing the saturated solution.

Results in parentheses are by Squire and Caines (1905), and are for 15°–20° instead of 25°.

SOLUBILITY OF QUININE SALTS IN SEVERAL SOLVENTS.
(Phelps and Palmer, 1917.)

| Salt. | M. pt. (uncorr.) | Solubility, Parts per 100 Parts Solvent in: | | | |
|---|---|---|---|---|---|
| | | $CCl_4$. | $CHCl_3$. (Alcohol free). | Ethyl Acetate (Alcohol free). | |
| | | | | Cold. | Hot. |
| Quinine racemic lactate | 165.5 | 0.00715 | 28.6 | 0.286 | 3.33 |
| " *d* lactate | 175 | 0.0111 | ... | 0.25 | ... |
| " *l* " | 171 | 0.00476 | ... | 0.20 | ... |
| " formate | 110–113 | 0.00625 | ... | ... | .... |
| " acetate | 124–126 | 0.05 | ... | ... | ... |
| " propionate | 110–111 | 0.238 | ... | ... | ... |
| " butyrate | 77.5 | 4 | ... | ... | ... |
| " succinate | 192 | 0.001 | ... | ... | 0.4 |
| " tartrate | 202.5 | 0.0004 | ... | ... | 0.0333 |
| " malate | 177.5 | 0.0008 | ... | ... | 0.5 |
| " citrate | 183.5 | 0.00167 | ... | ... | 0.0833 |
| " sulfate | 214 | 0.0025 | 0.0333 | 0.00715 | 0.0133 |
| Quintoxime lactate | ... | 0.11 | ... | ... | ... |

Saturation was obtained by shaking at intervals by hand, during 72 hours. In case of the determination at "hot," the solutions were boiled under a reflux condenser for 18 hours.

**QUININE TRICHLOR ACETATE** $C_{20}H_{24}O_2N_2.CCl_3COOH.4H_2O$.

100 gms. sat. solution of quinine trichlor acetate in water contain 3.43 gms. of the salt ($?.4H_2O$) at 15° and 29.98 gms. at 58°. (Florence, 1927.)

**QUININE FORMATE** (basic) $C_{20}H_{24}O_2N_2.HCOOH.H_2O$.

SOLUBILITY OF QUININE FORMATE IN AQUEOUS SOLUTIONS OF ANTIPYRINE AND OF URETHAN AT 15°.
(Musso and Monnet, 1935.)

Results for aqueous solutions of:

Antipyrine

| Gms. per 100cc solution | |
|---|---|
| Antipyrine | $C_{20}H_{24}O_2N_2.HCOOH.H_2O$ |
| 5.0 | 7.5 |
| 10.0 | 8.4 |
| 15.0 | 9.9 |
| 20.0 | 12.0 |
| 30.0 | 15.2 |
| 40.0 | 18.4 |
| 50.0 | 20.9 |

Urethan

| Gms. per 100cc solution | |
|---|---|
| Urethan | $C_{20}H_{24}O_2N_2.HCOOH.H_2O$ |
| 0.0 | 5.0 |
| 5.0 | 6.3 |
| 10.0 | 7.6 |
| 20.0 | 12.9 |
| 30.0 | 17.2 |
| 40.0 | 20.0 |
| 50.0 | 22.8 |

**QUININE HYDROCHLORIDE** $C_{20}H_{24}N_2O_2.HCl.2H_2O$.

100 cc. sat. solution of quinine hydrochloride in water contain 3.207 gms. $C_{20}H_{24}N_2O_2.HCl.2H_2O$ at 18°, 4.911 gms. at 25° and 9.242 gms. at 35°. Constant agitation was employed and the saturated solutions were analyzed by the Volhard titration method for chlorine.
(Oliveri-Mandala and Carh, 1925; Oliveri-Mandala, 1926.)

100 gms. 86.5 % Glycerol ($d = 1.2326$) dissolve 14.3 gms. Quinine hydrochloride at 20°
" 98.5 % " ($d = 1.2645$) " 16.8 " "
(Holm, 1921, 1922.)

## Solubility of Quinine Hydrochloride in Aqueous Salt Solutions at 16°

(Tarugi, 1914.)

The determinations were made by adding an aqueous solution of quinine hydrochloride to the aqueous salt solution until turbidity occurred. From the volumes involved, the solubility per 100 cc. was calculated.

| In Aq. NaCl. Gms. per 100 cc. Sol. | | In Aq. $NaNO_3$. Gms. per 100 cc. Sol. | | In Aq. KCl. Gms. per 100 cc. Sol. | | In Aq. $CaCl_2$. Gms. per 100 cc. Sol. | |
|---|---|---|---|---|---|---|---|
| NaCl. | Q.HCl. | $NaNO_3$. | Q.HCl. | KCl. | Q.HCl. | $CaCl_2$. | Q.HCl. |
| 2.02 | 2.6 | 0.677 | 2.85 | 2.63 | 2.545 | 6.37 | 1.028 |
| 2.49 | 1.94 | 0.970 | 1.96 | 3 | 1.882 | 7.03 | 0.951 |
| 3.40 | 1.22 | 2.008 | 0.67 | 5.57 | 0.804 | 7.75 | 0.879 |
| 8.34 | 0.54 | 3.65 | 0.43 | 8.26 | 0.531 | 7.96 | 0.765 |
| 11.40 | 0.205 | 9.31 | 0.292 | 10.42 | 0.407 | 34.42 | 0.183 |
| 15.56 | 0.140 | 19.12 | 0.168 | 17.87 | 0.205 | | |
| 19.83 | 0.085 | 31.78 | 0.0663 | 25.74 | 0.0997 | | |

100 cc. 90% alcohol dissolve 20 gms. Q. bihydrochloride at 15°–20°.
" chloroform " 14.3 " " " " "
" 90% alcohol " 14.3 " Q. hydrochlorosulfate at 15°–20°.
" " " " 0.5 " Q. glycerophosphate at 15°–20°.

(Squire and Caines, 1905.)

100 gms. $H_2O$ dissolve 1.3 gms. anhydrous Q. glycerophosphate at 100°.

(Rogier and Fiore, 1913.)

## Solubility of Quinine Hydrochloride in Aqueous Solutions of Antipyrine.

(Oliveri-Mandala and Carli, 1925.)

Constant agitation in a thermostat was employed and the saturated solutions were analyzed for chlorine by the Volhard method.

| Results at 18°. Gms. per 100 cc. sat. sol. | | Results at 25°. Gms. per 100 cc. sat. sol. | | Results at 35°. Gms. per 100 cc. sat. sol. | |
|---|---|---|---|---|---|
| Antipyrine. | $C_{20}H_{24}N_2O_2.HCl.2H_2O$. | Antipyrine. | $C_{20}H_{24}N_2O_2.HCl.2H_2O$. | Antipyrine. | $C_{20}H_{24}N_2O_2.HCl.2H_2O$. |
| 4.001 | 8.712 | 1.992 | 7.128 | 1.992 | 12.038 |
| 5.546 | 11.206 | 4.004 | 9.900 | 4.004 | 14.732 |
| 6.504 | 12.553 | 5.546 | 12.513 | 5.546 | 17.424 |
| | | 6.504 | 14.414 | 6.504 | 19.166 |

Note. — There is some uncertainty in regard to the terms in which the results of Oliveri-Mandala and Carli are expressed.

## Solubility of Quinine Hydrochloride in Aqueous Solutions of Antipyrine and of Urethan at 15°.

(Musso and Monnet, 1935.)

Results for aqueous solutions of:

### Antipyrine

| Gms. per 100cc solution | |
|---|---|
| Antipyrine | $C_{20}H_{24}O_2N_2.HCl.2H_2O$ |
| 0 | 3.9 |
| 5 | 10.7 |
| 10 | 16.8 |
| 15 | 25.0 |
| 20 | 31.0 |
| 25 | 36.0 |
| 40 | 47.0 |

### Urethan

| Gms. per 100cc solution | |
|---|---|
| Urethan | $C_{20}H_{24}O_2N_2.HCl.2H_2O$ |
| 0 | 3.9 |
| 2.5 | 6.0 |
| 5 | 8.5 |
| 10 | 15.0 |
| 15 | 30.2 |
| 20 | 40.8 |
| 25 | 50.2 |

SOLUBILITY OF QUININE HYDROCHLORIDE IN AQUEOUS SOLUTIONS OF URETHAN AT 20°.

(Malquori, 1932.)

| Gms. per 100 gms. solution | |
|---|---|
| $NH_2COOC_2H_5$ | $C_{20}H_{24}O_2N_2.HCl.2\,H_2O$ |
| 6.90 | 14.15 |
| 10.50 | 22.00 |
| 13.70 | 28.10 |

The author also gives results for the freezing-points of mixtures of Quinine hydrochloride and Urethan as well as the densities and refractive indices of aqueous quine hydrochloride urethan solutions.

**QUININE GLYCERO PHOSPHATE** $(OC_3H_7O_2)OPO.O(C_{20}H_{24}N_2O_2)_24H_2O$.

100 gms. $H_2O$ dissolve 1.28 gms. of the anhydrous compound at 100°.

(H. Rogier, *These*, Paris, 1912.)

**QUININE HELIANTHATE** $C_{14}H_{15}N_3SO_3.C_{20}H_{24}N_2O_2$.

1000 cc. $H_2O$ dissolve 0.185 gm. quinine helianthate at 20-25°.

(Stark and Dehn, 1918.

**QUININE** Hypo **PHOSPHITE** $C_{20}H_{24}N_2O_2.H_3PO_2.2\,H_2O$.

100 gms. sat. solution of quinine hypophosphite in water contain 4.07 gms. $C_{20}H_{24}N_2O_2.H_3PO_2.2\,H_2O$ at 15°.6 (Dott, 1922.)

**QUININE ETHYL CARBONATE**

100 gms. $C_6H_6$ dissolve 29.8 gm. quinine ethyl carbonate at 25°. (Warren, 1933.)
" " Pet. ether " 1.22 " " " " " " " " "

**QUININE IODO BISMUTHATE** $C_{20}H_{24}O_2N_2(BiI_3)_2.2HI$.

SOLUBILITY OF QUININE IODO BISMUTHATE IN ACETONE.

(Picon, 1934.)

Completely dried quinine iodo bismuthate when dissolved in anhydrous acetone forms two layers. The composition of the original salt and of the residue obtained by evaporation of the acetone solution are identical, thus showing that dissociation does not occur. The presence of very small amounts of $H_2O$ increases greatly the amount of salt dissolved; with 4% $H_2O$ two layers are no longer formed. Commercial samples of the salt give results differing from those of the pure compound. Evidence was obtained that the iodo bismuthate combines with six molecules of acetone and the product looses its powder form and becomes a perfectly clear viscous liquid. The iodo bismuthate is soluble in cyclo hexane and in diethylene glycol in all proportions and cyclo hexane can be employed for extracting quinine iodo bismuthate precipitated in aqueous solutions.

| | Lighter layer | | Heavier layer | |
|---|---|---|---|---|
| $t^0$ | Density | Gms. $C_{20}H_{24}O_2N_2(BiI_3)_2.2HI$ per 100 cc sat. sol. | Density | Gms. $C_{20}H_{24}O_2N_2(BiI_3)_2.2HI$ per 100 cc sat. sol. |
| 9 | 0.8159 | 2.64 | 1.473 | 94.20 |
| 19 | 0.8063 | 1.97 | 1.544 | 104.9 |
| 29 | 0.7981 | 1.54 | 1.609 | 115.3 |
| 39 | 0.7882 | 1.11 | 1.673 | 123.2 |
| 49 | 0.7793 | 0.8 | 1.732 | 130.2 |

**QUININE SALICYLATE** $C_{20}H_{24}N_2O_2.C_6H_4(OH)COOH.2H_2O$.

SOLUBILITY IN AQUEOUS ALCOHOL AT 25°.
(Seidell, 1909, 1910.)

| Wt. % $C_2H_5OH$ in Solvent. | $d_{25}$ of Sat. Sol. | Gms. Q. Sal. $2H_2O$ per 100 Gms. Sat. Sol | Wt. % $C_2H_5OH$ in Solvent. | $d_{25}$ of Sat. Sol. | Gms. Q. Sal. $2H_2O$ per 100 Gms. Sat. Sol. |
|---|---|---|---|---|---|
| 0 | 0.999 | 0.065 | 60 | 0.896 | 2.45 |
| 10 | 0.982 | 0.080 | 70 | 0.876 | 3.25 |
| 20 | 0.966 | 0.200 | 80 | 0.854 | 4.20 |
| 30 | 0.952 | 0.48 | 90 | 0.832 | 4.71 |
| 40 | 0.935 | 1 | 92.3 | 0.826 | 4.62 |
| 50 | 0.916 | 1.70 | 100 | 0.797 | 3.15 |

**QUININE SULFATE** $(C_{20}H_{24}N_2O_2)_2H_2SO_4.7H_2O$.

100 gms. 86.5 % Glycerol ($d = 1.2326$) dissolve 0.71 gms. Quinine sulfate at 20°
» 98.5 » ($d = 1.2645$) » 1.31 » »
(Holm, 1921, 1921 *a*, 1922.)

SOLUBILITY OF QUININE SULFATE IN SEVERAL SOLVENTS AT 25°.
(Schaefer, 1913.)

| Solvent. | Gms. Q. Sulfate per 100 cc. Solvent. | Solvent. | Gms. Q. Sulfate per 100 cc. Solvent. |
|---|---|---|---|
| Ethyl Alcohol | 0.4 | 1 vol. $C_2H_5OH$ + 4 vols. $CHCl_3$ | 12.5 |
| Methyl Alcohol | 3.12 | 1 vol. $C_2H_5OH$ + 4 vols. $C_6H_6$ | 0.53 |
| Chloroform | 0.27 | 1 vol. $CH_3OH$ + 4 vols. $CHCl_3$ | 20 |
| Benzene | insol. | 1 vol. $CH_3OH$ + 4 vols. $C_6H_6$ | 4.76 |

100 gms. trichlorethylene dissolve 0.07 gm. Q. sulfate at 15°. (Wester and Bruins, 1914.)

**QUININE TANNATES** True and False

SOLUBILITY IN WATER AND IN AQUEOUS HCl AT 37°. (Muraro, 1908.)

| Tannate. | Formula. | Gms. Q. Tannate per 100 Gms. $H_2O$. | Aq. 1% HCl. | Aq. 3% HCl. |
|---|---|---|---|---|
| True Tannate I | $C_{20}H_{24}N_2O_2.C_{10}H_{14}O_9.4H_2O$ | 0 | 0.984 | 3.656 |
| True Tannate II | $(C_{20}H_{24}N_2O_2)_2.(C_{10}H_{14}O_9)_3.8H_2O$ | 0 | 1.210 | 4.756 |
| False Tannate | $(C_{20}H_{24}N_2O_2.H_2SO_4)_2(C_{10}H_{14}O_9)_6.14H_2O$ | 0.313 | 0.847 | 1.560 |

The work of Muraro is criticized by Biginelli (1908).
100 cc. 90% alcohol dissolve 33.3 gms. Q. tannate at 15°–20°. (Squire and Caines, 1905.)

**QUININE PYROTARTRATES** *l*, *i*, *d*.

SOLUBILITIES IN ALCOHOL AT 18°. (Ladenburg and Herz, 1898.)

100 gms. alcohol dissolve 15 gms. of the *l* pyrotartrate, 3.2 gms. of the *i* and 4.2 gms of the *d* compound. The results show that the *i* acid is not a mixture of *d* and *l* acid, and, therefore, that the *i* quinine compound is a salt of the racemic acid.

SOLUBILITY OF QUININE AND OF QUININE SALTS IN WATER AND OTHER SOLVENTS. (U. S. P. VIII.)

| Compound. | Gms. Quinine Compound per 100 Gms. Solvent in: Water. At 25°. | Water. At 80°. | Alcohol. At 25°. | Ether. At 25°. | Chloroform. At 25°. | Glycerol. At 25°. |
|---|---|---|---|---|---|---|
| $C_{20}H_{24}N_2O_2$ | 0.057 | 0.123 | 166.6 | 22.2 | 52.6 | 0.633 |
| $C_{20}H_{24}N_2O_2.3H_2O$ | 0.065 | 0.129 | 166.6 | 76.9 | 62.5 | 0.472 |
| $C_{20}H_{24}N_2O_2HCl.2H_2O$ | 5.55 | 250 | 166.6 | 0.417 | 122 | 12.2 |
| $C_{20}H_{24}.N_2O_2.C_6H_4(OH).COOH.\frac{1}{2}H_2O$ | 1.30 | 2.86 | 9.09 | 0.91 | 2.70 | 6.25 |
| $(C_{20}H_{24}N_2O_2)_2.H_2SO_4.7H_2O$ | 0.139 | 2.22 | 1.16 | ... | 0.25 | 2.78 |
| $C_{20}H_{24}N_2O_2.H_2SO_4.7H_2O$ | 11.77 | 147 | 5.55 | 0.056 | 0.109 | 5.55 |
| $C_{20}H_{24}N_2O_2.HBr.H_2O$ | 2.5 | 33.3 | 149.2 | 6.2 | ... | 12.5 |

## QUINIDINE $C_{20}H_{24}N_2O_2.?H_2O$.

### Solubility of Quinidine in Water at 18°. (Kolthoff, 1925.)

The first and second *dissociation constants*, as estimated by colorimetric titration curve of $p_H$, were found to be $K_1 = 3.7.10^{-6}$ and $K_2 = 1\ 0.10^{-10}$.

The *solubility product* of quinidine was determined by adding 0.01 *n* Na OH to 4 cc. of a 0.013 molecular quinidine sulfate solution untill a precipitate just appeared after a period of 1 day; 0.08 cc. were required and the $p_H$ of the solution was 7.6, hence the $p_{OH} = 6.6$ and $[OH] = 2.5.10^{-7}$. From this

$$L_{Quinidine} = [Quinidine.OH\cdot]\,[OH'] = 2.5.10^{-9}.$$

Calculating from this and the first dissociation constant the solubility of quinidine in water is $6.7.10^{-4} + 0.5.10^{-4} = 7.2.10^{-4}$ gm. mols. per liter.

A saturated solution of *quinidine sulfate* in water at 18° was found to have a concentration of 0.026 gm. mol. per liter and a $p_H$ of 5.9.

### Solubility of Quinidine in Several Solvents.

| Solvent. | t°. | Gms. $C_{20}H_{24}N_2O_2$ per 100. Gms. Solvent. | cc. Solvent. | Authority. |
|---|---|---|---|---|
| Water | 18–22 | 0.020 | ... | (Müller, 1903.) |
| Water | 25 | ... | 0.0145 | (Schaefer, 1910.) |
| Ethyl Alcohol (95%) | 20 | 4 | ... | (Wherry & Yanovsky, 1918.) |
| Ethyl Alcohol | 25 | ... | 2.22 | (Schaefer, 1913.) |
| Methyl Alcohol | 25 | ... | 0.66 | " |
| Benzene | 25 | ... | 1.19 | " |
| Benzene | 18–22 | 2.45 | ... | (Müller, 1903.) |
| Carbon Tetrachloride | 18–22 | 0.557 | ... | " |
| Chloroform | 18–22 | 100+ | ... | " |
| Chloroform | 25 | ... | 25 | (Schaefer, 1913.) |
| Ether ($d = 0.72$) | 18–22 | 0.78 | ... | (Müller, 1903.) |
| Ether sat. with $H_2O$ | 18–22 | 1.63 | ... | " |
| $H_2O$ sat. with Ether | 18–22 | 0.031 | ... | " |
| Ethyl Acetate | 18–22 | 1.76 | ... | " |
| Pet. Ether (b. pt. 59°–64°) | 18–22 | 0.024 | ... | " |
| 1 vol. $C_2H_5OH$+4 vols. $CHCl_3$ | 25 | ... | 33.3 | (Schaefer, 1913.) |
| 1 vol. $C_2H_5OH$+4 vols. $C_6H_6$ | 25 | ... | 12.5 | " |
| 1 vol. $CH_3OH$+4 vols. $CHCl_3$ | 25 | ... | 25 | " |
| 1 vol. $CH_3OH$+4 vols. $C_6H_6$ | 25 | ... | 6.6 | " |

## QUINIDINE SALTS

### Solubility in Water at 25°.

(Schaefer, 1910.)

| Quinidine Salt. | Gms. Salt per 100 Gms. $H_2O$. | Quinidine Salt. | Gms. Salt per 100 Gms. $H_2O$. |
|---|---|---|---|
| Q. Hydrobromide | 0.526 | Q. Sulfate | 1.05 |
| Q. Hydrochloride | 1.160 | Q. Tannate | 0.0477 |
| Q. Hydroiodide | 0.082 | Q. Tartrate | 2.86 |
| Q. Salicylate | 0.060 | Q. Bitartrate | 0.323 |

### Solubility of Quinidine Sulfate in Several Solvents at 25°.

(Schaefer, 1913.)

| Solvent. | Gms. Q. Sulfate per 100 cc. Solvent. | Solvent. | Gms. Q. Sulfate per 100 cc. Solvent. |
|---|---|---|---|
| Ethyl Alcohol | 5 | 1 vol. $C_2H_5OH$+4 vols. $CHCl_3$ | 33.3 |
| Methyl Alcohol | 40 | 1 vol. $C_2H_5OH$+4 vols. $C_6H_6$ | 8.33 |
| Chloroform | 8.33 | 1 vol. $CH_3OH$+4 vols. $CHCl_3$ | 33.3 |
| Benzene | Insol. | 1 vol. $CH_3OH$+4 vols. $C_6H_6$ | 20 |

**METHYL PROPYL AZO PHENOL** $[C_6H_2(CH_3)(C_3H_7)OH]_2N_2$.

Freezing-point data are given for mixtures of methyl propyl azo phenol and azo anisol phenetol by Bogojawleusky and Winogradow, 1907.

**AMYGDALIN** $C_{20}H_{27}NO.3H_2O$.

100 gms. trichlorethylene dissolve 0.029 gm. amygdalin at 15°.
(Wester and Bruins, 1914.)

**ELATERIN** $C_{20}H_{28}O_5$.

100 cc. 90% alcohol dissolve 0.09 gm. elaterin at 15–20. (Squire and Caines, 1905.)
100 cc. chloroform dissolve 4 gms. elaterin at 15–20. " "

**ARACHIDIC ACID** $CH_3(CH_2)_{18}COOH$.

Freezing-point data are given by von Meyer, Brod and Soyka, 1913, for mixtures of arachidic acid with stearic, palmitic and lignoceric acid.

**ETHYL STEARATE** $CH_3(CH_2)_{16}COOC_2H_5$.

Freezing-point data are given for:

Ethyl Stearate + Ethyl Margarate (Carey and Smith, 1933.)
" " + Ethyl Palmitate (Smith, 1931.)

**HYDROBENZAMIDE** $(C_6H_5CH)_3N_2$.

100 gms. absolute alcohol dissolve 1.99 gms. $(C_6H_5CH)_3N_2$ at 20-25° (Pucher and Dehn, 1921.)
» quinoline » 3.94 » » » »
» equimol mixture of alcohol and quinoline dissolve 2.56 gms. $(C_6H_5CH)_3N_2$ at 20-25°

**TRI BENZYL AMINE** $(C_6H_5CH_2)_3N$.

Freezing-point data for mixtures of tribenzyl amine and bromo toluene are given by Paterno and Ampola, 1897.

**METHYLENE ANILINE** (s Triazine hexa hydro, 1,3,5-triphenyl) $(C_6H_5N.CH_2)_3$.

Freezing-point data for mixtures of methylene aniline and mercapto-benzothiazol are given by Kojima and Nagai, 1931.

**HYDRASTINE** $C_{21}H_{21}NO_6$.

Solubility of Hydrastine in Water at 15°. (Kolthoff, 1925.)

From colorimetric $p_H$ determinations made in mixtures composed of 0.01 *n* hydrastine hydrochloride and 0.01 *n* NaOH solutions the dissociation constant was calculated to be $K = 1.7.10^{-8}$. It was found that 5 cc. of hydrastine HCl + 1.0 cc. of 0.01 *n* NaOH gave a trace of crystalline deposit after one day. The sat. sol. had $p_H = 5.7$ and $p_{OH} = 8.5$. From this and other determinations it was concluded that solid hydrastine was in equilibrium with a solution which was $7.10^{-3}$ normal with respect to hydrastine salt and had a hydroxyl ion concentration of $2.10^{-9}$. Therefore, the solubility product $L_{hydrastine} = 1.4.10^{-11}$ and from this and K the solubility of hydrastine in water was calculated to be $8.2.10^{-4}$ mols. per liter at 15°.

SOLUBILITY OF HYDRASTINE AND OF HYDRASTININE HYDROCHLORIDE IN SEVERAL SOLVENTS.

(U. S. P. VIII; at 18°–22°, Müller, 1903.)

| Solvent. | Gms. $C_{21}H_{21}NO_6$ per 100 Gms. Solution. At 18°–22°. | At 80°. | Solvent. | Gms. per 100 Gms. Solution at 18°–22°. $C_{21}H_{21}NO_6$. | $C_{11}H_{11}NO_2.HCl$. |
|---|---|---|---|---|---|
| Water | 0.033 | 0.025 | Ether | 0.51 | 0.078 (25°) |
| Alcohol | 0.74 (25°) | 5.9 (60°) | Ether+$H_2O$ | 0.80 | ... |
| Benzene | 8.89 | ... | Chloroform | 100+ | 0.35 (25°) |
| Ethyl Acetate | 4.05 | ... | $CCl_4$ | 0.123 | ... |
| Petroleum Ether | 0.073 | | | | |

## STRYCHNINE $C_{21}H_{22}N_2O_2$.

SOLUBILITY OF STRYCHNINE IN WATER. (Kolthoff, 1925.)

The dissociation constantes calculated from $p_H$ values determined colorimetrically in mixtures of dilute standard solutions of strychnine nitrate and sodium hydroxide, were $K_1 = 10.10^{-7}$ and $K_2 = 2.2.10^{-12}$. For the determination of the solubility product 5 cc. of 0.025 molecular strychninc nitrate solution gave a faint trace of crystalline precipitatc with 0.75 cc. of 0.01 *n* Na OH solution. The precipitated strychnine was, accordingly, in equilibrium with a 0.02 *n* strychninc nitrate solution which was found to havc a $p_H$ value of 6.5. This corrcsponds to a $p_{OH}$ of 7.7 or a [OH] of $2.10^{-8}$ and the solubility product $L_{Strychnine} = 4.10^{-10}$. Calculating from $K_1$ and L the concentration of a saturated aqueous solution of strychnine is $4.2.10^{-4}$ mol. per liter at 15°. A direct determination of the solubility of strychnine in water, madc by Mauz, gave $2.7.10^{-4}$ mol. strychnine per liter at 15°.

100cc. of sat. sol. of Strychnine in pure acetone contain 0.132 gms. $C_{21}H_{22}N_2O_2$ at 15°
» » » in Ether of $d = 0.720$ » 0.034 » »
(Harvey and Back, 1921.

100 gms. *p* cymene dissolve 0.71 gm. strychnine at 30° and 0.95 gm. at. 100°. (Wheeler, 1920.)

SOLUBILITY OF STRYCHNINE IN SEVERAL SOLVENTS.

| Solvent. | t°. | Gms. $C_{21}H_{22}N_2O_2$ per 100 Gms. Solvent. | Solvent. | t°. | Gms. $C_{21}H_{22}N_2O_2$ per 100 Gms. Solvent. |
|---|---|---|---|---|---|
| Water | ord.t. | 0.014 (1) | Carbon Tetrachloride | 20 | 0.158 (5) |
| " | 20 | 0.0125 (2) | " " | 20 | 0.22 (9) |
| " | 20 | 0.0143 (3) | " " | 17 | 0.645 (10) |
| " | 25 | 0.016 (4) | Chloroform | 25 | 10.25 (6) |
| " | 20 | 0.021 (5) | " | 25 | 16.6 (14) |
| Aq. 10%$NH_3$ | 20 | 0.033 (3) | Diethylamine | 20 | 1.7 (3) |
| Aq. 3% $H_3BO_3$ in 50% Glycerol | ord.t. | 3.5 (1) | Ethyl Acetate | 20 | 0.197 (5) |
| $C_2H_5OH$ ($d$=0.83) | 15–20 | 0.71 (7) | Ether | 20 | 0.043 (5) |
| " ($d$=0.83) | 20 | 0.833 (3) | " | 25 | 0.018 (4) |
| " ($d$=0.83) | 25 | 0.91 (4) | " sat. with $H_2O$ | 20 | 0.051 (5) |
| " " +10% $NH_3$ | 20 | 0.256 (3) | Glycerol | 15 | 0.25 |
| " ($d$=0.785) | 25 | 0.70 (6) | Petroleum Ether | 20 | 0.0093 (5) |
| $CH_3OH$ ($d$=0.796) | 25 | 0.49 (6) | Piperidine | 20 | 0.7 (3) |
| Aniline | 20 | 20 (3) | Pyridine | 20 | 1.5 (3) |
| Amyl Alcohol | 25 | 0.55 (4) | " | 26 | 1.24 (11) |
| Benzene | 20 | 0.77 (5) | Aq. 50 % Pyridine | 20–25 | 2.43 (8) |
| " | 25 | 0.76 (6) | Water sat. with Ether | 20 | 0.017 (5) |
| | | | Oil of Sesame | 20 | 0.061 (2) |

(1) Baroni and Barlinetto (1911); (2) Zalai (1910); (3) Scholtz (1912); (4) U. S. P. 8th ed.; (5) Müller (1903); (6) Schaefer (1913); (7) Squire and Caines (1905); (8) Dehn (1917); (9) Gori (1913); (10) Schindelmeiser (1901); (11) Holty (1905).

100cc Olive oil dissolve 0.32 gms. strychnine at 25°. (Walton, 1935.)

Data showing the effect of increasing amounts of several gum arabic sols upon the solubility of strychnine in water are given by Brintzinger and Beier, 1934.

### Solubility of Strychnine in Aqueous Alcohol at 15°–20°.
(Squire and Caines, 1905.)

| Per cent Alcohol in Solvent | 20 | 45 | 60 | 70 | 90 |
|---|---|---|---|---|---|
| Gms. $C_{21}H_{22}N_2O_2$ per 100 cc. solvent | 0.024 | 0.125 | 0.25 | 0.40 | 0.59 |

### Solubility of Strychnine in Mixtures of Ether and Chloroform at 25°.
(Marden and Dover, 1916.)

| Per cent $CHCl_3$ in Mixed Solvent. | Gms. $C_{21}H_{22}N_2O_2$ per 100 Gms. Mixed Solvent. | Per cent $CHCl_3$ in Mixed Solvent. | Gms. $C_{21}H_{22}N_2O_2$ per 100 Gms. Mixed Solvent. |
|---|---|---|---|
| 100 | 15.3 | 50 | 0.35 |
| 90 | 7.1 | 30 | 0.21 |
| 80 | 2.77 | 20 | 0.15 |
| 70 | 1.5 | 10 | 0.09 |
| 60 | 0.65 | 0 | 0.02 |

### Solubility of Strychnine in Mixed Solvents at 25°.
(Schaefer, 1913.)

| Mixture. | Gm. $C_{21}H_{22}N_2O_2$ per 100 cc. of Mixture. |
|---|---|
| One volume of $C_2H_5OH$ + 4 vols. $CHCl_3$ | 25 |
| One volume of $C_2H_5OH$ + 4 vols. $C_6H_6$ | 5 |
| One volume of $CH_3OH$ + 4 vols. $CHCl_3$ | 25 |
| One volume of $CH_3OH$ + 4 vols. $C_6H_6$ | 6.7 |

### Distribution of Strychnine between Water and Chloroform at 25°.
(Seidell, 1910a.)

| Gm. $C_{21}H_{22}N_2O_2$ Added per 15 cc. $H_2O$ + 15 cc. $CHCl_3$. | Gms. $C_{21}H_{22}N_2O_2$ Recovered per 15 cc: | | $\frac{(b)}{(a)}$. |
|---|---|---|---|
| | $H_2O$ Layer (*a*). | $CHCl_3$ Layer (*b*). | |
| 0.005 | 0.0006 | 0.0103(?) | ... |
| 0.025 | 0.0010 | 0.0253 | 25.2 |
| 0.125 | 0.0021 | 0.1299 | 61 |
| 0.625 | 0.0099 | 0.6225 | 64 |

### STRYCHNINE TRICHLOR ACETATE $C_{21}H_{22}N_2O_2.CCl_3COOH.3H_2O$.

100 gms. sat. solution of strychnine trichlor acetate in water contain 4.03 gms. $C_{21}H_{22}N_2O_2.CCl_3COOH.(?).3H_2O$ at 15° and 20.75 gms. at 52°. (Florence, 1927.)

### STRYCHNINE ARSENATE $C_{21}H_{22}N_2O_2.H_3AsO_4.\frac{1}{2}H_2O(.1\frac{1}{2}H_2O)$.

100 gms. sat. solution in water contain 4.53 gms. $C_{21}H_{22}N_2O_2.H_3AsO_4$ at 25°. (Puckner and Warren, 1910.)

100 gms. $CHCl_3$ dissolve 0.085 gm. $C_{21}H_{22}N_2O_2.H_3AsO_4$ at 15°. (Hill, 1910.)

### STRYCHNINE FORMATE $C_{21}H_{22}N_2O_2.HCOOH.2H_2O$.

#### Solubility in Water and in Alcohol.
(Hampshire and Pratt, 1913.)

| Solubility in Water. | | Solubility in Abs. Alcohol. | |
|---|---|---|---|
| t°. | Gms. Salt per 100 Gms. $H_2O$. | t°. | Gms. Salt per 100 Gms. $C_2H_5OH$. |
| 19.5 | 30.59 | 18.5 | 10 |
| 24 | 39.68 | 20 | 10.3 |
| 27 | 44.25 | 22 | 10.64 |

## STRYCHNINE BENZOATE $C_{21}H_{22}N_2O_2.C_6H_5COOH$.

### Solubility of Strychnine Benzoate and of a Series of Substituted Benzoates in Water at Several Temperatures.

(Poe, Suchy and Baker, 1934.)

The saturated solutions were analyzed by evaporating to dryness on the water bath and weighing the residue.

| Strychnine Salt | Gms. Strychnine Salt per 100 cc sat. solution at: 20° | 30° | 40° | 50° | 60° | 75° | 95° |
|---|---|---|---|---|---|---|---|
| Benzoate | 0.433 | 0.578 | 0.784 | 1.156 | 1.607 | 2.311 | 3.460 |
| o Chloro Benzoate | 1.783 | 1.995 | 2.211 | 2.770 | 3.410 | 4.793 | 10.725 |
| m " " | 0.170 | 0.229 | 0.349 | 0.509 | 0.669 | 0.944 | 1.376 |
| p " " | 0.264 | 0.302 | 0.330 | 0.425 | 0.551 | 0.688 | 1.158 |
| o Bromo " | 1.063 | 1.204 | 1.410 | 1.846 | 2.470 | 3.818 | 6.751 |
| m " " | 0.092 | 0.115 | 0.141 | 0.201 | 0.402 | 0.576 | 0.835 |
| p " " | 0.211 | 0.244 | 0.299 | 0.351 | 0.528 | 0.744 | 0.915 |
| o Iodo " | 0.526 | 0.582 | 0.653 | 0.768 | 1.122 | 1.514 | 2.116 |
| p " " | 0.167 | 0.195 | 0.229 | 0.341 | 0.475 | 0.606 | 0.840 |
| o Nitro " | 0.521 | 0.621 | 0.724 | 0.928 | 1.320 | 1.970 | 3.140 |
| m " " | 0.447 | 0.565 | 0.706 | 0.896 | 1.359 | 2.452 | 4.138 |
| p " " | 0.183 | 0.222 | 0.266 | 0.328 | 0.467 | 0.698 | 0.970 |
| o Hydroxy " | 0.250 | 0.297 | 0.402 | 0.606 | 0.964 | 1.470 | 2.500 |
| m " " | 0.179 | 0.185 | 0.335 | 0.432 | 0.562 | 0.872 | 1.517 |
| p " " | 0.149 | 0.188 | 0.241 | 0.339 | 0.517 | 0.875 | 1.432 |
| o Methyl " | 0.519 | 0.634 | 0.984 | 1.331 | 1.958 | 2.807 | 4.142 |
| m " " | 0.869 | 0.992 | 1.181 | 1.688 | 2.350 | 3.856 | 7.765 |
| p " " | 0.560 | 0.578 | 0.625 | 0.828 | 0.931 | 1.250 | 1.808 |
| o Amino " | 0.297 | 0.378 | 0.462 | 0.710 | 0.984 | 1.590 | 2.602 |
| m " " | 1.092 | 1.204 | 1.437 | 2.107 | 2.971 | 4.786 | 7.963 |
| p " " | 0.371 | 0.652 | 0.986 | 1.324 | 2.046 | 3.586 | 7.136 |
| 3,5-Dinitro " | 0.136 | 0.163 | 0.197 | 0.271 | 0.384 | 0.599 | 0.951 |
| 2,4- " " | 0.249 | 0.298 | 0.389 | 0.557 | 0.821 | 1.230 | 1.610 |
| 2,4,6 Trinitro" | 0.075 | 0.098 | 0.116 | 0.165 | 0.273 | 0.450 | 0.717 |
| 5-Iodo Salicylate | 0.037 | 0.045 | 0.057 | 0.079 | 0.126 | 0.215 | 0.374 |
| 3,5-Dinitro " | 0.025 | 0.041 | 0.063 | 0.088 | 0.116 | 0.422 | 1.064 |
| Di iodo " | 0.020 | 0.023 | 0.031 | 0.032 | 0.046 | 0.071 | 0.127 |

## STRYCHNINE HYDROBROMIDE $C_{21}H_{22}N_2O_2.HBr$.

100 cc. $H_2O$ dissolve 1.54 gms. of the salt at 15°–20°. (Squire and Caines, 1905.)
100 cc. 90% alcohol dissolve 1.04 gm. of the salt at 15°–20°. " "

## STRYCHNINE HYDROCHLORIDE $C_{21}H_{22}N_2O_2.HCl$.

100 cc. $H_2O$ dissolve 2.86 gms. of the salt at 15°–20°. (Squire and Caines, 1905.)
100 cc. 90% alcohol dissolve 1.37 gms. of the salt at 15°–20°. " "
100 gms. $CHCl_3$ dissolve 0.592 gm. of the salt at 15°. (Hill, 1910.

## STRYCHNINE HYDRO IODIDE $C_{21}H_{22}N_2O_2.HI.H_2O$.

100cc sat. solution of strychnine iodide in water contain 0.287 gm. $C_{21}H_{22}N_2O_2.HI.?H_2O$ at 25°. (Hargreaves, 1931.)

**STRYCHNINE HELIANTHATE** $C_{14}H_{15}N_3SO_3.C_{21}H_{22}N_2O_2$.

1000 cc. $H_2O$ dissolve 0.481 gm. strychnine helianthate at 20-25°.
(Stark and Dehn, 1918.)

**STRYCHNINE SULFONPROPIONATE** *d* and *l* $C_3H_6O_5S.C_{21}H_{22}N_2O_2H_2O$.

Solubility of the Dextro and of the Laevo Salts, Separately, in Water at 24°.6. (Franchimont and Backer, 1920.)

| Compound. | Formula. | Gms. anhydrous compound per 100 gms. sat. sol |
|---|---|---|
| *d* Strychnine Sulfonpropionate.. | $C_3H_6O_5S.C_{21}H_{22}N_2O_2.H_2O$ | 6.0 |
| *l* " | " | 27.7 |

**STRYCHNINE NITRATE** $C_{21}H_{22}N_2O_2.HNO_3$.

Solubility in Several Solvents.

| Solvent. | t°. | Gms. Salt per 100 cc. Solvent. | Solvent. | t°. | Gms. Salt per 100 cc. Solvent. |
|---|---|---|---|---|---|
| Water | 15 | 1.4 (1) | $CH_3OH$ | 25 | 0.345 (3) |
| " | 15–20 | 1.6 (2) | $CHCl_3$ | 25 | 1.25 (3) |
| " | 25 | 2.38 (4) | 1 vol. $C_2H_5OH$+4 vols. $CHCl_3$ | 25 | 5 (3) |
| " | 80 | 12.5 (4) | 1 vol. $C_2H_5OH$+4 vols. $C_6H_6$ | 25 | 0.66 (3) |
| 90% $C_2H_5OH$ | 15–20 | 0.83 (2) | 1 vol. $CH_3OH$+4 vols. $CHCl_3$ | 25 | 4 (3) |
| " " | 15 | 0.77 (1) | 1 vol. $CH_3OH$+4 vols. $C_6H_6$ | 25 | 1 (3) |
| " " | b. pt. | 3.45 (1) | Glycerol | 25 | 1.66 (4) |
| 100% $C_2H_5OH$ | 25 | 0.37 (3) | | | |

(1) Dott (1910); (2) Squire and Caines (1905); (3) Schaefer (1913); (4) U. S. P. VIII ed.

Distribution of Strychnine Nitrate between Water and Chloroform at 25°.
(Seidell, 1910a.)

| Gms. $C_{21}H_{22}N_2O_2.HNO_3$ Added per 15 cc. $H_2O$ + 15 cc. $CHCl_3$. | Gms. $C_{21}H_{22}N_2O_2.HNO_3$ per 15 cc.: $H_2O$ Layer (*a*). | $CHCl_3$ Layer (*b*). | $\frac{a}{b}$. |
|---|---|---|---|
| 0.005 | 0.0051 | 0.0030 (?) | ... |
| 0.025 | 0.0222 | 0.0042 | 5.3 |
| 0.125 | 0.1017 | 0.0243 | 4.2 |
| 0.625 | 0.3250 | 0.1698 | 2 |

**STRYCHNINE OXALATE**

100 gms. $H_2O$ dissolve 1.13 gms. of the anhydrous salt at about 15°.
(Dott, 1910.)

**STRYCHNINE PERCHLORATE** $C_{21}H_{22}N_2O_2.HClO_4$.

100 gms. $H_2O$ dissolve 0.022 gm. perchlorate at 15°.
(Hofmann, Roth, Höbold and Metzler, 1910.)

**STRYCHNINE SULFATE** $(C_{21}H_{22}N_2O_2)_2.H_2SO_4.5H_2O$.

Solubility in Several Solvents.

| Solvent. | t°. | Gms. Salt per 100 cc. Solvent. | Solvent. | t°. | Gms. Salt per 100 cc. Solvent. |
|---|---|---|---|---|---|
| Water | 15–20 | 2.08 (1) | $CHCl_3$ | 15 | 0.05 (4) |
| " | 25 | 3.23 (2) | " | 25 | 0.31 (2) |
| " | 80 | 16.6 (2) | " | 25 | 0.43 (3) |
| 90% $C_2H_5OH$ | 15–20 | 0.74 (1) | 1 vol. $C_2H_5OH$+4 vols. $CHCl_3$ | 25 | 12.8 (3) |
| 94% " | 25 | 1.9 (2) | 1 vol. $C_2H_5OH$+4 vols. $C_6H_6$ | 25 | 0.725 (3) |
| 94% " | 60 | 6.2 (2) | 1 vol. $CH_3OH$+4 vols. $CHCl_3$ | 25 | 25 (3) |
| 100% " | 25 | 0.8 (3) | 1 vol. $CH_3OH$+4 vols. $C_6H_6$ | 25 | 12.5 (3) |
| $CH_3OH$ | 25 | 8.33 (3) | Glycerol | 15 | 18 (2) |

(1) Squire and Caines (1905); (2) U. S. P. VIII; (3) Schaefer (1913); (4) Hill (1910).

## STRYCHNINE TARTRATE

SOLUBILITY OF *d*, *l* AND OF RACEMIC STRYCHNINE TARTRATE IN WATER.
(Dutilh, 1912.)

| t°. | Gms. of Each Separately per 1000 gms. $H_2O$. | | |
|---|---|---|---|
| | *d* Tartrate. | *l* Tartrate. | Racemic Tartrate. |
| 7.35 | 14.14 | 9.48 | 14.02 |
| 16 | 17.72 | 11.50 | 19.12 |
| 25 | 22.9 | 14.52 | 24.70 |
| 27 | ... | 15.60 | ... |
| 30 | ... | 17.02 | ... |
| 40 | 35.18 | 22.90 | 38.42 |

SOLUBILITY OF MIXTURES OF *d* AND *l* TARTRATES AND OF RACEMIC STRYCHNINE TARTRATE IN WATER.
(Ladenburg and Doctor, 1899.)

| Results for $d + l$ Tartrate. | | | Results for Racemic Tartrate. | | |
|---|---|---|---|---|---|
| t°. | Gms. Anhydrous Salt per 100 Gms. $H_2O$. | Solid Phase. | t°. | Gms. Anhydrous. Salt per 100 Gms. $H_2O$. | Solid Phase. |
| 7 | 1.48 | 50% *d* + 5% *l* | 7 | 1.39 | Racemic Tartrate |
| 19 | 1.95 | " | 19 | 1.90 | " |
| 27 | 2.38 | " | 27 | 2.33 | " |
| 35 | 3.02 | " | 35 | 3.17 | " |
| 42 | 3.75 | " | 42 | 3.92 | " |

100 gms. sat. solution in water contain 0.45 gm. anhydrous strychnine acid tartrate at about 15°. (Dott, 1910.)

## DIACETYL MORPHINE (Heroin) $C_{17}H_{17}(CH_3COO)_2NO$.

100cc $H_2O$ dissolve 0.06 gm. diacetyl morphine at 25°.
100cc Olive oil dissolve 1.0 gm. diacetyl morphine at 25°. (Walton, 1935.)

## CRYPTOPINE PICRATE $C_{21}H_{23}NO_5.HO.C_6H_2(NO_2)_3$ (m. pt. 161°–3°).

100 gms. sat. solution in water contain 0.007 gm. of the compound at 15°.
" " $C_2H_5OH$ " 0.022 " " " "
" " acetone " 0.162 " " " "
(Maplethorpe and Evers, 1925.)

## TOLUIDINE HELIANTHATES *o* and *m* $C_7H_9N.C_{14}H_{15}N_3SO_3$.

1000 cc. water dissolve 0.270 gm. *o* Toluidine Helianthate at 20-25°
" " 0.162 " *m* " "
(Stark and Dehn, 1918.)

## YOHIMBINE (Quebrachine) $C_{21}H_{26}N_2O_3$.

100 gms. $C_2H_5OH$ dissolve 4.0 gms. $C_{21}H_{26}N_2O_3$ cold and 10.0 gms. at b. pt.
" " $H_2O$ " 0.735 gms. $C_{21}H_{26}N_2O_3.HCl$ cold and 3.33 gms. at b. pt.
" " " " 0.36 gm. $(C_{21}H_{26}N_2O_3)_2C_2H_2O_4$ (oxalate) at the b. pt.
" " $C_2H_5QH$ " 0.27 gm. $(C_{21}H_{26}N_2O_3)_2C_4H_7O_6.6H_2O$, (tartrate) cold and 0.625 gm. at the b. pt.
(Fourneau and Page, 1914.)

## α NAPHTHOL AZINE $C_{10}H_7CH:N.N.CHC_{10}H_7$.

Freezing-point data for mixtures of α Naphthol azine and Benzalazine are given by Pascal, 1914.

## METHYL (and Other) ETHER OXIDES

Solubility of Methylic, Ethylic and of Propylic Ether Oxides of Phenyl Ethinyldiphenyl Carbinols in Several Solvents.
(Moureu, Dufraisse and Blatt, 1924.)

| Solvent | Gms. per 100 gms. sat. solution. t°. | Cmpd. A. | t°. | Cmpd. B. | t°. | Cmpd. C. |
|---|---|---|---|---|---|---|
| Methyl alcohol..... | 15.8 | 0.2 | 15.9 | 2.7 | 16.2 | 4.7 |
| Ethyl » ..... | 15.8 | 0.2 | 15.9 | 3.4 | 16.2 | 4.8 |
| Propyl » ..... | 15.9 | 0.5 | 15.9 | 7.0 | 16.2 | 9.9 |
| Petroleum ether (b. pt. 50-60°)... | 16.0 | 0.9 | 16.0 | 27.3 | 16.0 | 62.5 |

Cmpd. A = $C_6H_5.C\equiv C.C.(C_6H_5)_2.OCH_3$;
Cmpd. B = $C_6H_5.C\equiv C.C.(C_6H_5)_2\ OC_2H_5$;
Cmpd. C = $C_6H_5.C\equiv C.C.(C_6H_5)_2.OC_3H_7$ (normal).

**GNOSCOPINE PICRATE** (m. pt. 185°.5). $C_{22}H_{23}NO_7.HOC_6H_3(NO_3)_2$.

100 gm sat. sol of gnoscopine picrate in water contain 0.009 gm of the cmpd. at 15°.
» » » » » » alcohol » 0.04 » » »
» » » » » » acetone » 2.34 » » »
(Maplethorpe and Evers, 1925.)

Methyl **CRYPTOPINES.** *A*, *B* and *C* forms, $C_{22}H_{25}O_5N$.

The solubilities of the three forms in benzene, determined by lowering of the freezing-point, are: 5 gms. *A* form per liter at 5°, 30 gms. *B* form and 110 gms. *C* form. (Sidgwick, 1915.)

**NARCOTINE** $C_{22}H_{23}NO_7$.

Solubility of Narcotine ($C_{22}H_{23}NO_7$) in Water at 18°. (Kolthoff, 1925.)

The dissociation constant was found to be $K = 1.5.10^{-8}$ The determination was beset with difficulties due to the extremely slight solubility of narcotine. The addition of a trace of alkali precipitates narcotine from a very dilute solution. As the result of many experiments it was found that narcotine was in equilibrium with a narcotine hydrochloride solution which was 0.00092 normal and had a $p_H$ of 5.0. That is a $p_{OH}$ of 9.2 or $[OH']$ of $6.4.10^{-10}$. From this the solubility product of narcotine $L_{Narcotine} = 9.2.10^{-4}.6.4.10^{-10} = 6.10^{-13}$. From L and K the solubility in water was calculated to be $4.10^{-5}$ mol., corresponding to 0.020 gms. narcotine per liter. A direct determination by Mauz gave 0.0174 gm. per liter.

**NARCOTINE PICRATE** $C_{22}H_{23}NO_2.OH.C_6H_2(NO_2)_3$.

100 gms. sat. sol. of Narcotine picrate in water contain 0.02 gm of the cmpd. at 20°.
» » abs. Alcohol » 0.13 » »
» » Acetone » 30.0 » »
See remarks under Morphine picrate, p. 774 (Mapelthorpe and Evers, 1925.)

**COLCHICINE** $C_{22}H_{25}NO_6$.

Solubility in Several Solvents.
(Müller, 1903; U. S. P.)

| Solvent. | t°. | Gms. $C_{22}H_{25}NO_2$ per 100 Gms. Solvent. | Solvent. | t°. | Gms. $C_{22}H_{25}NO_6$ per 100 Gms. Solvent. |
|---|---|---|---|---|---|
| Water | 18–22 | 9.6 | Water sat. with Ether | 18–22 | 12.05 |
| " | 25 | 4.5 | Benzene | 18–22 | 0.94 |
| " | 80 | 5 | Benzene | 25 | 1.15 |
| " | 82 | 13.7* | Chloroform | 18–22 | 100+ |
| Ether | 18–22 | 0.13 | Carbon Tetrachloride | 18–22 | 0.12 |
| " | 25 | 0.64 | Ethyl Acetate | 18–22 | 1.34 |
| " sat. with $H_2O$ | 18–22 | 0.18 | Petroleum Ether | 18–22 | 0.06 |

* Beilstein.

## COLCHICINE SALTS.

| Name. | Formula. | Solvent. | t°. | Gms. Salt per Liter Sat. Sol. | Authority. |
|---|---|---|---|---|---|
| Colchicine Iodohydrate | $C_{22}H_{25}NO_6.HI$ | Water | 30 | 0.84 | (Pfannl, 1911.) |
| Iso Colchicine Iodohydrate | " | " | 30 | 3.86 | " |
| Colchicine Silicotungstate | $(C_{22}H_{25}NO_6)_5SiO_2.12WO_3.2H_2O$ | " | 15 | 0.083 | (Jensen, 1913.) |
| | | Aq. 1% HCl | 15 | 0.007 | " |

## NARCEINE $C_{22}H_{27}NO_8$.

Solubility of Narceine in Water at 18° (Kolthoff, 1925.)

Narceine hydrochloride is so strongly hydrolyzed that it does not dissolve in water. A 0.01 mol. solution yields crystals on cooling. The dissociation constants determined in very dilute solutions were: basic constant $K_b = 2.10^{-11}$, acid constant $K_S = 5.10^{-10}$. Hence narceine is a stronger acid than base The isoelectric point is near $p_H = 6.4$ and here the narceine has a minimum solubility, which was calculated to be $1.3.10^{-3}$ mol. per liter.

The solubility product as a base is $L_{\text{Narceine OH}} = [\text{Narc}\cdot][\text{OH}'] = 2.6.10^{-14}$.
» » an acid is $L_{\text{Narceine H}} = [\text{Narc}'][\text{H}\cdot] = 6.5.10^{-13}$.

## NARCEINE PICRATE.

100 gms. sat. sol. of Narceine picrate in water contain 0.027 gm of the cmpd. at 20°.
» » abs. Alcohol » 0.01 » »
» » Acetone » 5.23 » »

See remarks under Morphine picrate, p. 774 (Mapelthorpe and Evers, 1925.)

## BENZYL PALMITATE, STEARATE, SULFIDE, etc.

Solubility in Several Solvents.

| Compound. | Formula. | Solvent. | t°. | Gms. cmpd. per 100 gms. solvent. | Authority. |
|---|---|---|---|---|---|
| Benzyl Palmitate..... | $C_6H_5CH_2.CH_3(CH_2)_{14}COO$ | $C_2H_5OH$ | 16 | 3.30 | (Whibey, 1926.) |
| Benzyl Stearate..... | $C_6H_5CH_2.CH_3(CH_2)_{16}COO$ | » | 16 | 0.685 | » |
| Benzyl Sulfide..... | $(C_6H_5CH_2)_2S$ | $CHCl_3$ | 20 | 133.91 | (Pawlewski 1914.) |
| » » ..... | » | $CCl_4$ | 20 | 73.16 | » |
| Benzyl Camphoroxime. | – | $CHCl_3$ | 20 | 93.68 | » |
| » » | – | » | 20 | 18.87 | » |

## BEHENOLIC ACID $CH_3(CH_2)_7C{:}C(CH_2)_{11}COOH$.

Freezing-point data for mixtures of behenolic with cholic and with hyodesoxycholic acid are given by Rheinboldt and Lauber, 1929.

## ERUCIC ACID $C_8H_{17}CH{:}CH(CH_2)_{11}COOH$.

Solubility in Alcohols.
(Timofeiew, 1894.)

| Alcohol. | t°. | Gms. Erucic Acid per 100 Gms. Sat. Sol. | Alcohol. | t°. | Gms. Erucic Acid per 100 Gms. Sat. Sol. |
|---|---|---|---|---|---|
| Methyl Alcohol | − 2 | 2.25 | Ethyl Alcohol | +21.4 | 63.4 |
| " " | +18 | 60.4 | Propyl Alcohol | − 2 | 10.2 |
| " " | 21.4 | 62 | " " | +18 | 60.5 |
| Ethyl Alcohol | − 2 | 8.24 | " " | 21.4 | 63 |

100 cc. of a sat. solution of erucic acid in 91.53 wt. per cent $C_2H_5OH$ contain 2.356 gms. $C_8H_{17}CH{:}CH(CH_2)_{11}CO.OH$ at 0°. (Thomas and Mattikow, 1926.)

**BEHENIC ACID** $C_{21}H_{43}COOH$.

SOLUBILITY IN AQUEOUS SOLUTIONS OF ETHYL ALCOHOL AT 0° AND 25°.
(Thomas and Mattikow, 1926.)

| Wt. per cent $C_2H_5OH$ in solvent. | Gms. $C_{21}H_{43}COOH$ per 100 cc. sat. sol. at 0°. | Gms. $C_{21}H_{43}COOH$ per 100 cc. sat. sol. at 25°. |
|---|---|---|
| 63.07 | 0.002 | 0.010 |
| 86.16 | 0.010 | 0.111 |
| 91.53 | 0.013 | 0.206 |

Freezing-point data are given for mixtures of:

Behenic acid + Erusic acid(3)
" " + Isoerusic acid(3)
" " + Brassidic acid(3)
" " + Iso behenic acid(4)
Methyl behenate + Methyl iso behenate(4)

Brassidic acid + Erusic acid(1)(2)(3)
" " + Iso erusic acid(3)
" " + Cholic acid(5)
" " + Hyodesoxycholic acid(5)
" " + Ethyl brassidate(2)
" " + Methyl " (2)

(1) Griffiths and Hilditch, 1932; (2) Keffler and Maiden, 1936; (3) Mascarelli and Sauna, 1915; (4) von Meyer, Brod and Soyka, 1913; (5) Rheinboldt and Lauber, 1929.

**ROTENONE** $C_{23}H_{22}O_6$

SOLUBILITY OF ROTENONE IN VARIOUS SOLVENTS AT 20°.
(Jones and Smith, 1930.)

The determinations of the concentration of the saturated solutions was based upon the optical activity of the compound. The specific rotation of rotenone in the various solvents was first determined and the concentration of the saturated solution estimated by extrapolation from the values obtained upon solutions of known concentration. The saturated solutions were prepared by constant agitation for 7 hours.

| Solvent | $d_{20}$ of sat. sol. | Gms. $C_{23}H_{22}O_6$ per 100 gms. sat. sol. | Solvent | $d_{20}$ of sat. sol. | Gms. $C_{23}H_{22}O_6$ per 100 gms. sat. sol. |
|---|---|---|---|---|---|
| Acetone | 0.825 | 8.0 | Chloro benzene | 1.127 | 12.0 |
| Acetic acid | 1.057 | 2.2 | Chloroform | 1.430 | 33.0 |
| n.Butyl Alcohol | 0.814 | 0.3 | s-β Dichloro ethyl ether | 1.228 | 6.1 |
| Ethyl alcohol | 0.792 | 0.3 | Ethyl ether | 0.721 | 0.5 |
| Iso propyl " | 0.790 | 0.2 | Ethyl acetate | 0.916 | 5.2 |
| Methyl " | 0.796 | 0.3 | Ethylene chlor hydrine | 1.210 | 9.4 |
| Amyl acetate | 0.872 | 1.8 | Ethylene di chloride | 1.270 | 26.1 |
| Benzene | 0.908 | 8.8 | n Propyl formate | 0.915 | 6.6 |
| Carbon disulfide | 1.270 | 1.3 | Toluene | 0.890 | 7.2 |
| Carbon tetra chloride | 1.587 | 0.4 | Tri chloro ethylene | 1.447 | 11.4 |
| | | | Xylene | 0.878 | 3.8 |

**TETRA METHYL DIAMINO TRIPHENYL CARBINOL** $C_6H_5COH[C_6H_4N(CH_3)_2]_2$.

Results for the freezing-points of the modifications of this compound from Ether and from Ligroin with tetra methyl diamino triphenyl methyl amine are given by Grimm, Gunther and Titus, 1931.

**BRUCINE** $C_{21}H_{20}(OCH_3)_2N_2O_2.4H_2O$.

Kolthoff, 1925, reports that the solubility of brucine in water, as determined by Mauz (Dissertation, Stuttgart, 1904), using the $.4H_2O$ compound is $1.33.10^{-3}$ gm. mol. per liter. From this value and the first dissociation constant ($K_1 = 9.2.10^{-7}$) he calculates the solubility product of brucine to be

$$L_{Brucine} = 9.2.10^{-7} \times 1.33.10^{-3} = 1.22.10^{-9}.$$

Solubility of Brucine in Mixtures of Alcohol and Quinoline at 20-25°.
(Pucher and Dehn, 1921.)

| Per cent $C_7H_9N$. in solvent. | Gms. Brucine per 100 gms. solvent. | Per cent $C_7H_9N$ in solvent. | Gms. Brucine per 100 gms. solvent. | Per cent $C_7H_9N$ in solvent. | Gms. Brucine per 100 gms. solvent. |
|---|---|---|---|---|---|
| 0.0..... | 3.5 (2.35) | 47.5..... | 34.6 | 80.0..... | 75.00 |
| 10.0..... | 3.86 | 50.0..... | 36.5 | 90.0..... | 78.7 |
| 23.2..... | 10.87 | 60.0..... | 44.6 | 100.0..... | 79.0 |
| 37.5..... | 15.09 | 70.0..... | 68.20 | | |

100 gms. equi. mol. mixture of alcohol and quinoline dissolve 43.51 gms. brucine at 20-25°. (Pucher and Dehn, 1921.)

**BRUCINE** $C_{21}H_{20}(OCH_3)_2N_2O_2.4H_2O$.

Solubility of Brucine in Several Solvents.

| Solvent. | t°. | Gms. Brucine per 100 Gms. Sat. Sol. | Authority. |
|---|---|---|---|
| Water | 18–22 | 0.056–0.125 | (Müller, 1903; Squire and Caines, 1905; Zalai, 1910.) |
| Aniline | 20 | 12 | (Scholtz, 1912.) |
| Benzene | 18–22 | 1.11–1.86 | (Müller, 1903; Schaefer, 1913.) |
| Carbon Tetrachloride | 18–22 | 0.08 | " " |
| " " | 20 | 1.96 | (Schindelmeiser, 1901; Gori, 1913.) |
| Chloroform | 25 | 11.6 | (Schaefer, 1913.) |
| Trichlor Ethylene | 15 | 2.5 | (Wester and Brüins, 1914.) |
| Ether | 18–22 | 0.75 | (Müller, 1903.) |
| Ethyl Acetate | 18–22 | 4.26 | " |
| Ethyl Alcohol | 25 | 45.2 | (Schaefer, 1913.) |
| Diethylamine | 20 | 1.6 | (Scholtz, 1912.) |
| Methyl Alcohol | 25 | 55.6 | (Schaefer, 1913.) |
| Petroleum Ether | 18–22 | 0.055–0.088 | (Müller, 1903; Zalai, 1910.) |
| Glycerol | 18–22 | 2.2 | (Müller, 1903.) |
| Pyridine | 20 | 28 | (Scholtz, 1912.) |
| " | 20–25 | 21.9 | (Dehn, 1917.) |
| Aq. 50% Pyridine | 20–25 | 31.6 | " |
| Piperidene | 20 | 1 | (Scholtz, 1912.) |

Results for the solubility of brucine and brucine sulfate in mixtures of alcohol, chloroform and benzene are given by Schaefer (1913).

**BRUCINE** Per **CHLORATE** $C_{21}H_{20}(OCH_3)_2N_2O_2.HClO_4$.

100 gms. $H_2O$ (+ 2% $HClO_4$) dissolve 0.15 gm. of the salt at 18°.
(Hofmann, Roth, Höbold and Metzler, 1910.)

**BRUCINE TRICHLORACETATE** $C_{23}H_{26}N_2O_4.CCl_3COOH.3H_2O$.

100 gms. sat. solution of brucine trichlor acetate in water contain 4.02 gms. $C_{23}H_{26}N_2O_4.CCl_3COOH.(?).3H_2O$ at 15° and 25.25 gms. at 53°. (Florence, 1927.

**BRUCINE HELIANTHATE** $C_{23}H_{26}N_2O_4.C_{14}H_{15}N_3SO_3.H_2O$.

100 gms. $H_2O$ dissolve 0.245 gms. $C_{23}H_{26}N_2O_4.C_{14}H_{15}N_3SO_3.H_2O$ at 20-25°.
(Stark and Dehn, 1918.)

**BRUCINE SULFATE.**

100 cc. methyl alcohol dissolve 0.28 gm. brucine sulfate at 25°. (Schaefer, 1913.)
" ethyl " " 1.66 " " " " " (Schaefer, 1913.)
" chloroform " 0.6 " " " " " (Schaefer, 1913.)

**BRUCINE** *d*, *l*, and *i* **TARTRATE.**

SOLUBILITY OF EACH OPTICAL ISOMER IN WATER (Dutilh, 1912.)

| t°. | Gms. per 100 Gms. Water. *d* Tartrate. | *l* Tartrate. | Racemic Tartrate. |
|---|---|---|---|
| 20 | ... | ... | 1.38 |
| 25 | 1.008 | 1.84 | ... |
| 35 | 1.272 | 3.24 | ... |
| 44 | 1.590 | 4.64 | ... |
| 50 | 1.854 | 6.56 | ... |

**NARCEINE** $C_{23}H_{27}NO_8 + 3H_2O$.

100 gms. $H_2O$ dissolve 0.078 gm. narceine at 13°; 100 gms. 80% alcohol dissolve 0.105 gm. at 13°.

100 gms. $CCl_4$ dissolve 0.011 gm. narceine at 17° (Schindelmeiser, 1901); 0.002 gm. at 20° (Gori, 1913).

**LIGNOCERIC ACID** $C_{23}H_{47}COOH$.

SOLUBILITY OF LIGNOCERIC ACID IN AQUEOUS ALCOHOL AT 25°.
(Thomas and Chai Lan Yu, 1923.)

The saturation was obtained by constant agitation and the saturated solutions were analyzed by evaporation and weighing the residue dried at 80°.

| Solvent. | $d_{25}$ of Sat. sol. | Gms. Lignoceric Acid dissolved: 100 cc. sat. sol. | 100 gms. solvent. |
|---|---|---|---|
| Aq. 63.07 Wt. % $C_2H_5OH$ ..... | 0.87783 | 0.011 | 0.013 |
| " 86.16 " " ..... | 0.82356 | 0.092 | 0.112 |
| " 91.53 " " ..... | 0.80935 | 0.182 | 0.226 |

Freezing-point data for mixtures of lignoceric with arachidic acid and other compounds are given by von Meyer, Brod and Soyka, 1913.

**TRIPHENYL BENZENE** $C_6H_3(C_6H_5)_3$.

Freezing-point data for mixtures of triphenyl benzene with triphenyl triazine and with methyl diphenyl triazine are given by Pascal, 1925.

**DIPHENYL BENZIDINE** $C_6H_5.NH.C_6H_4.C_6H_4.NH.C_6H_5$.

SOLUBILITY OF DIPHENYL BENZIDINE IN AQUEOUS SOLUTIONS OF HYDROCHLORIC ACID.
(Kolthoff and Sarver, 1930.)

| Normality of aq. HCl | Gms. $C_{24}H_{22}N_2$ per liter |
|---|---|
| 0.1 | 0.00007 |
| 0.25 | 0.00009 |
| 0.5 | 0.00012 |
| 1.0 | 0.00017 |
| 2.0 | 0.00028 |

**DIPROPYL AZOPHENOL** $[C_6H_2(C_3H_7)_2OH]_2N_2$.

Freezing-point data for mixtures of dipropyl azophenol with azophenetol and with azoanisol phenetol are given by Bogojawlenski and Winogrado, 1907.

**CHOLIC ACID** $C_{24}H_{40}O_5$.

Freezing-point data are given for mixtures of:

Cholic acid + Cetyl alcohol(3)
" " + Behenolic acid(3)
" " + Brassidic acid(3)
" " + Palmitic acid(3)
" " + Stearic acid(3)
" " + Stearolic acid(3)
Desoxy cholic acid + Cetyl alcohol(2)
" " " + Palmitic acid(2)
" " " + Stearic acid(2)
Allocholic acid + Cholanic acid(1)
Apocholic acid + Montanic acid(4)
" " + Palmitic acid(2)
" " + Stearic acid(2)
Hyodesoxy cholic acid + Cetyl alcohol(3)
" " " + Palmitic acid(3)
" " " + Stearic acid(3)

(1) Bonstedt, 1932; (2) Rheinboldt, Flume and König, 1929; (3) Rheinboldt and Lauber, 1929; (4) Rheinboldt, Pieper and Zervas. 1926.

**STEARANILIDE** $CH_3(CH_2)_{16}CONHC_6H_5$.

Freezing-point data for mixtures of Stearanilide and palmitanilide are given by Guy and Smith, 1939.

**PHENACYL LIGNOCERATE** $CH_3(CH_2)_{20}COOCH_2COC_6H_5$.

SOLUBILITY OF PHENACYL, BROMOPHENACYL AND CHLOROPHENACYL LIGNOCERATES IN 95% ETHYL ALCOHOL.
(Hann, Reid and Jameson, 1930.)

| Lignocerate | Formula | Gms. Lignocerate per 100cc 95% alcohol at 20° | 25° |
|---|---|---|---|
| Phenacyl Lignocerate | $CH_3(CH_2)_{22}COOCH_2COC_6H_5$ | 0.1209 | 0.1816 |
| p Bromo " " | $CH_3(CH_2)_{22}COOCH_2COC_6H_4Br$ | 0.0040 | 0.0070 |
| p Chloro " " | $CH_3(CH_2)_{22}COOCH_2COC_6H_4Cl$ | 0.0054 | 0.0072 |

Tetraphenyl **ETHYLENE** $(C_6H_5)_2C{:}C(C_6H_5)_2$.
Freezing-point data for tetraphenyl ethylene + silicotetraphenyl are given by Pascal and Normand (1913).

**NARINGEN** $C_{27}H_{32}O_{14}.2H_2O$.

SOLUBILITY OF NARINGEN IN WATER.
(Pulley, 1936.)

The saturated solutions were prepared by intermittent agitation during two hours and the dissolved solid was determined by evaporation, drying the residue at 110°, and weighing.

| t° | Gms. $C_{27}H_{32}O_{14}$ per liter sat. sol. | Solid Phase | t° | Gms. $C_{27}H_{30}O_{14}$ per liter sat. sol. | Solid Phase |
|---|---|---|---|---|---|
| 6 | 0.17 | $C_{27}H_{32}O_{14}.6H_2O$(?) | 45 | 1.96 | $C_{27}H_{30}O_{14}.2H_2O$(?) |
| 20 | 0.50 | " | 55 | 7.16 | " |
| 35 | 0.79 | | 65 | 42.21 | " |
| | | | 75 | 108.24 | |

**ERGOSTEROL** $C_{27}H_{42}O$.

Freezing-point data are given for mixtures of:

Allo-α-ergostan + Cholestan (Bonstedt, 1932.)
" " + Cholestanol " "
" " + Stigmastan " "
Dihydro ergosterol + Epidihydro ergosterol (Lettre, 1930.)

**CHOLESTEROL** $C_{27}H_{45}OH$.

100 gms. $H_2O$ dissolve 0.26 gm. cholesterol at 20–25°. (Dehn, 1917.)
" pyridine " 68.10 gms. " " " " "
" 50% aq. pyridine " 1.10 " " " " "
100 cc. $H_2O$ dissolve 0.0006 gm. cholesterol-digitonide at b. pt. (Mueller, 1917.)
100 cc. ether dissolve 0.0007 gm. cholesterol-digitonide at room temp. "

### Solubility of Cholesterol in Aqueous Bile Salt Solutions at 37°.
(Bashour and Bauman, 1937.)

Recrystallized commercial cholesterol in large excess was constantly shaken with the bile salt solutions for 4 days. After standing 2 days the supernatant solution was filtered and the dissolved cholesterol determined by a modified gravimetric method and the total solids by evaporation and drying at 100° and at 138°. The bile salts were prepared by titration of the bile acids in dilute alcoholic solution with sodium hydroxide, evaporating to dryness and recrystallizing. The results are given only in the form of a diagram from which the following approximate values were estimated.

| Gms. Bile salt per 100 gms. aq. solution | Gms. Cholesterol dissolved per gram of (Sodium): Tauro cholate | Glycocholate | Taurodesoxy cholate | Diolate | Glycodesoxy cholate | Desoxy cholate |
|---|---|---|---|---|---|---|
| 2 | 0.003 | 0.005 | 0.008 | 0.022 | 0.035 | 0.036 |
| 4 | 0.007 | 0.010 | 0.016 | 0.027 | 0.040 | 0.050 |
| 6 | 0.011 | 0.014 | 0.024 | 0.028 | 0.040 | 0.056 |
| 8 | 0.013 | 0.019 | 0.029 | 0.028 | 0.040 | 0.059 |
| 10 | 0.014 | 0.022 | 0.036 | 0.028 | 0.040 | 0.059 |
| 12 | 0.0145 | 0.023 | 0.038 | — | 0.040 | 0.0595 |
| 14 | 0.015 | 0.024 | 0.0385 | — | 0.040 | 0.060 |

### Solubility of Stearic Acid Ester of Cholesterol in Oils at 37° and Vice Versa. (Filehne, 1907.)

The determinations were made by adding small weighed amounts of the ester to the oil at 60° and cooling to 36–37° while stirring continually. The additions of the ester were repeated until a clouding just appeared at 36–37°. In the case of the solubility of the oils in cholesterol, the composition of the sat. solution was estimated by means of the specific gravity and the melting point.

| Solvent. | t° of Clouding. | Gms. Ester per 100 Gms. Oil. | Solute. | Gms. Oil or Acid per 100 Gms. Sat. Solution in Ester, Det. by: Sp. Gr. | M. pt. |
|---|---|---|---|---|---|
| Olive Oil | 37.6 | 3.35 | Olive Oil | 25.5 | 33.8 |
| Castor Oil | 37.6 | 0.26 | Oleic Acid | 37 | 40 |
| Oleic Acid | 37.5 | 4.11 | Castor Oil | 5 | 1.85 |
| Ricinic (Oil) Acid | 37 | 0.33 | Ricinic Acid | 20 | 16 |
| Pseudo Ricinic Acid | 36.2 | 0.85 | Pseudo Ricinic Acid | 10 | 12 |
| Crotonic (Oil) Acid | 36.5 | 0.87 | Crotonic Acid | (5) | 5 |

## Solubility of Cholesterol in Solvent Mixtures at 20°.

(Weichherz and Marschik, 1932.)

Results for mixtures of:

### Water + Ethyl Alcohol

| Wt. % $C_2H_5OH$ in Solvent | Gms. $C_{27}H_{45}OH$ per 100 gms. solvent |
|---|---|
| 55.15 | 0.0207 |
| 76.53 | 0.1629 |
| 100.0 | 1.5524 |

### Water + Dioxane

| Wt. % $C_4H_8C_2$ in solvent | Gms. $C_{27}H_{45}OH$ per 100 gms. solvent |
|---|---|
| 60.72 | 0.0291 |
| 80.83 | 0.8589 |
| 100.0 | 11.2588 |

### Dioxane + Ethyl Alcohol

| Wt. % $C_4H_8O_2$ in solvent | Gms. $C_{27}H_{45}OH$ per 100 gms. solvent |
|---|---|
| 24.42 | 3.2413 |
| 46.33 | 5.1172 |
| 65.93 | 6.8794 |
| 84.12 | 8.9430 |

### Benzene + Dioxane

| Wt. % $C_6H_6$ in solvent | Gms. $C_{27}H_{45}OH$ per 100 gms. solvent |
|---|---|
| 0.0 | 11.2588 |
| 36.19 | 16.2642 |
| 55.93 | 19.2046 |
| 77.29 | 18.8614 |
| 87.24 | 16.8454 |
| 100.0 | 14.2449 |

### Benzene + Hexane

| Wt. % $C_6H_6$ solvent | Gms. $C_{27}H_{45}OH$ per 100 gms. solvent |
|---|---|
| 0.0 | 1.9237 |
| 24.35 | 7.6756 |
| 46.20 | 16.0599 |
| 66.06 | 21.1094 |
| 76.54 | 22.0439 |
| 83.83 | 19.5527 |

### Ethyl Alcohol + Hexane

| Wt. % $C_2H_5OH$ solvent | Gms. $C_{27}H_{45}OH$ per 100 gms. solvent |
|---|---|
| 0.0 | 1.9237 |
| 22.39 | 22.5148 |
| 43.81 | 23.9777 |
| 63.83 | 15.8880 |
| 82.68 | 6.4291 |
| 100.0 | 1.5524 |

### Ethyl Alcohol + Benzene

| Wt. % $C_2H_5OH$ in solvent | Gms. $C_{27}H_{45}OH$ per 100 gms. solvent | Wt. % $C_2H_5OH$ in solvent | Gms. $C_{27}H_{45}OH$ per 100 gms. solvent |
|---|---|---|---|
| 0.0 | 14.2449 | 37.73 | 28.6971 |
| 9.19 | 26.3662 | 47.42 | 24.5236 |
| 18.49 | 33.2489 | 57.74 | 17.7339 |
| 23.25 | 32.6185 | 78.50 | 5.8785 |

### Dioxane + Hexane

| Wt. % $C_4H_4O_2$ in solvent | Gms. $C_{27}H_{45}OH$ per 100 gms. solvent |
|---|---|
| 33.50 | 24.2723 |
| 43.05 | 31.2329 |
| 60.67 | 33.0814 |
| 82.08 | 26.3415 |

The authors also give the following values for the solubility of cholesterol in other solvents at 20°.

| Solvent | Gms. $C_{27}H_{45}OH$ per 100 gms. solvent |
|---|---|
| Methyl alcohol | 0.6500 |
| Furfural | 0.3342 |
| Iso butyl alcohol | 6.3444 |
| n Amyl alcohol | 10.5397 |

## Solubility of Non-Radiated Cholesterol in Liquid Ammonia.

(Gustavson and Goodman, 1927.)

| t° | Gm. $C_{27}H_{45}OH$ per 100 cc $NH_3$ |
|---|---|
| -38 | 0.000 |
| 0 | 0.00616 |
| 7 | 0.0202 |
| 14 | 0.0272 |
| 21 | 0.0726 |
| 28 | 0.1172 |
| 35 | 0.2322 |
| 42 | 0.3012 |
| 49 | 0.5450 |

Freezing-point data are given for mixtures of:

| | | |
|---|---|---|
| Cholesterol + Antipyrine | (Pfeiffer and Seydel, 1928.) | |
| " + Dimethyl amino antipyrine | " " " | " |
| " + Pyramidon | " " " | " |
| " + Sarcosine anhydride | " " " | " |
| " + Oleic acid | (Partington, 1911,) | |
| " + Palmitic acid | " | " |
| " + Stearic acid | " | " |
| Cholesterol acetate + Phytosterol (α and β) | (Jaeger, 1907.) | |
| " formate + Cholesterol Butyrate | (Robberecht, 1938.) | |
| " " + " Valerianate | " | " |
| " valerianate + " Acetate | " | " |
| " butyrate + " " | " | " |
| " " + " Formate | " | " |
| " benzoate + p Azoxy phenetol | (Prins, 1909.) | |
| " propionate + " " " | " | " |
| " iso butyrate + " " " | " | " |
| " " " + Anisal amino acetophenone | (Robberecht, 1938.) | |
| Cholestan + Sitostan | (Bonstedt, 1932.) | |
| " + Sitostanol | " | " |

**DESOXY BENZOIN PINACONE** $[C_6H_5CH_2C(OH)C_6H_5]_2$.

Freezing-point data for mixtures of desoxy benzoin pinacone and tetra phenyl butadien are given by Bergmann, Winter and Schreiber, 1933.)

**PORPHYRINS** $C_{33}H_{34}N_4O_3$.

Determinations of the distribution coefficients of six pure porphyrins between ethyl ether and aqueous solutions of hydrochloric acid, varying from 0.025 to 10% HCl, made by fluorescent measurements, are given by Keys and Brugsch, 1938.

**CEPHAELINE** Salts.

SOLUBILITY IN WATER. (Carr and Pyman, 1914.)

| Salt. | Formula. | t°. | Gms. Hydrated Salt per 100 cc. Sat. Sol. |
|---|---|---|---|
| Cephaeline Hydrochloride | $C_{28}H_{38}O_4N_2.2HCl.7H_2O$ | 17–18 | 26.5 |
| " acid " | $C_{28}H_{38}O_4N_2.5HCl$ | 18 | about 50 |
| " Hydrobromide | $C_{28}H_{38}O_4N_2.2HBr.7H_2O$ | 17–18 | 5.4 (dried at 100°) |

**CELLOBIOSE** Octa **ACETATE** $C_{12}H_{14}O_{11}(CH_3CO)_8$.

DISTRIBUTION BETWEEN CHLOROFORM AND AQUEOUS SOLUTIONS OF CALCIUM THIOCYANATE.

(Herzog and Bergenthun, 1923.)

Ten cubic centimeter portions of chloroform and of aqueous calcium thiocyanate were shaken 12 hours (at room temp.,?) with the quantities of cellobios octa acetate shown. The acetate present in 5 cc. portions of the chloroform before and after the period of shaking, was determined by evaporation and weighing the residue.

Results for aqueous $Ca(SCN)_2$ solutions of

| 9.08 Normality | | 8.68 Normality | | 7.90 Normality | |
|---|---|---|---|---|---|
| Gms. Acetate used per 10 cc. | Distribution coef. | Gms. Acetate used per 10 cc. | Distribution coef. | Gms. Acetate used per 10 cc. | Distribution coef. |
| 0.0478 | 3.20 | 0.0525 | 0.58 | 0.0525 | 0.03 |
| 0.0966 | 3.86 | 0.1018 | 0.56 | 0.1018 | 0.06 |
| 0.1912 | 3.61 | 0.2000 | 0.56 | 0.2000 | 0.04 |
| 0.3314 | 3.38 | 0.3506 | 0.56 | 0.3506 | 0.05 |
| 0.4700 | 3.33 | 0.4762 | 0.57 | 0.4762 | 0.04 |

**AZOANISOLE PHENETOL** $(C_6H_4OCH_3.C_6H_4OC_2H_5)_2N_2$.

Freezing-point data are given by Bogojawleusky and Winogradow, 1907, for mixtures of azoanisole phenetol with each of the following compounds: azoanisole, azoxyanisole, azooxy phenetol, azo phenetol, dipropyl azo phenol and methyl propyl azo phenol.

**CHRYSAROBIN** $C_{30}H_{36}O_7$.

Solubility in Several Solvents.
(U. S. P.)

| Solvent. | Gms. per 100 Gms. Solvent at: 25°. | 80°. | Solvent. | Gms. per 100 Gms. Solvent at 25°. |
|---|---|---|---|---|
| Water | 0.021 | 0.046 | Chloroform | 5.55 |
| Alcohol | 0.324 | 0.363 (60°) | Ether | 0.873 |
| Benzene | 4 | ... | Amyl Alcohol | 3.33 |
| | | | Carbon Disulfide | 0.43 |

**EMETINE** $C_{30}H_{40}N_2O_4$.

Solubility in Water. (Kolthoff, 1925.)

The dissociation constants were found to be $K_1 = 2.3.10^{-7}$ and $K_2 = 1.7.10^{-6}$. The solubility product, calculated as a mono acid base is $L_{Emetine\ OH} = 3.7.5.10^{-9}$. From this and $K_1$ the solubility was calculated to be $2.10^{-3}$ gm. mol. per liter at 15°.

100cc Olive Oil dissolve 1.0 gm. emetine at 25°. (Walton, 1935.)

**EMETINE** Salts.

Solubility in Water.
(Carr and Pyman, 1914.)

| Salt. | Formula. | t°. | Gms. Hydrated Salt per 100 cc. Sat. Sol. |
|---|---|---|---|
| Emetine Hydrochloride | $C_{29}H_{40}O_4N_2.2HCl.7H_2O$ | 18 | 13.1 |
| " Hydrobromide | $C_{29}H_{40}O_4N_2.2HBr.4H_2O$ | 17–18 | 1.9 |
| " Nitrate | $C_{29}H_{40}O_4N_2.2HNO_3.3H_2O$ | 17–18 | 3.7 |
| " Sulfate | $C_{29}H_{40}O_4N_2.H_2SO_4.7H_2O$ | 17–18 | more than 100 |

100 gms. sat. solution of Emetine hydrochloride in water contain 16.53 gms. $C_{29}H_{40}N_2O_4.2HCl$ at 25°. (Schnellbach and Rosin, 1931.)

**PICROTOXIN** $C_{30}H_{34}O_{13}$.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 100 gms. $H_2O$ | dissolve | 0.41+ | gm. | picrotoxin | at | 20–25°. | (Dehn, 1917.) |
| " pyridine | dissolve | 102 | gms. | " | " | " | " |
| " aq. 50% pyridine | " | 81 | " | " | " | " | " |

**CARYOPHYLLIN** $C_{30}H_{48}O_3$.

Approximate Solubility in Several Solvents. (Dodge, 1918.)

| Solvent. | t°. | Gms. $C_{30}H_{48}O_3$ per 100 gms. solvent. | Solvent. | t°. | Gms. $C_{30}H_{48}O_3$ per 100 gms. solvent. |
|---|---|---|---|---|---|
| 95 % alcohol..... | 20 | 0.943 | Ether..... ..... | 20 | 1.538 |
| 95 % alcohol..... | b. pt. | 2.857 | Chloroform ..... | 20 | 0.847 |
| Acetone..... | 20 | 0.555 | Methyl alcohol .... | 20 | 0.425 |

**URSON** $C_{30}H_{48}O_3.2H_2O$.

100 gms. 95 % alcohol dissolve about 0.9 gm. Urson at 20° and 2.8 gms. at the b. pt.

100 gms. Ether dissolve about 1.5 gm. Urson at 20°. (Dodge, 1918.)

**ANDROMEDOTOXINE** $C_{31}H_{51}O_{10}$.

SOLUBILITY IN SEVERAL SOLVENTS AT 12° AND AT THE BOILING-POINTS OF THE SOLVENTS.

(Zaayer, 1886.)

| Solvent. | Gms. $C_{31}H_{51}O_{10}$ per 100 Gms. Sat. Sol. at: 12°. | B. Pt. |
|---|---|---|
| Water | 2.81 | 0.87 |
| Ethyl alcohol ($d_{12} = 0.821$) | 11.70 | ... |
| Amyl alcohol | 1.14 | ... |
| Chloroform | 0.26 | 0.26 |
| Commercial ether | 0.07 | 0.07 |
| Benzine | 0.004 | ... |

**VERATRINE** (Cevadine) $C_{32}H_{49}NO_9$.

SOLUBILITY OF VERATRINE IN WATER. (Kolthoff, 1925.)

The *dissociation constant* was calculated from colorimetric $p_H$ measurements in mixtures of 0.01 *n* veratrine hydrochloride and 0.01 *n* Na OH to be $K = 7.2.10^{-6}$. It is, therefore, a fairly strong base. For the determination of the *solubility product* it was found that a mixture of 5.0 cc. of 0.05 *n* veratrine hydrochloride + 0.8 cc. 0.01 *n* Na OH gave no precipitate after standing 1 day. With 0.9 cc. 0.1 *n* Na OH a crystalline deposit appeared. The $p_H$ of the saturated solution was 8.5. The $[OH] = 2.10^{-6}$. The veratrine salt conc. $= 3.10^{-2}$ *n* and the calculated solubility product, $L_{Veratrine} = 6.10^{-8}$. From K and L the solubility of veratrine was calculated to be $8.10^{-3}$ gm. mols. per liter at 15°.

SOLUBILITY OF VERATRINE IN SEVERAL SOLVENTS.

| Solvent. | t°. | Gms. Veratrine per 100 Gms. Solvent. | Authority. |
|---|---|---|---|
| Water | 25 | 0.057 | (U. S. P. VIII.) |
| Water | 20 | 0.114 | (Zalai, 1910.) |
| 3% $H_3BO_3$ in Aq. | | | |
| 50% Glycerol | ord. | 6 | (Baroni & Barlinetto, 1911.) |
| Aniline | 20 | 37 | (Scholtz, 1912.) |
| Pyridine | 20 | 175 | " |
| Piperidine | 20 | 83 | " |
| Diethylamine | 20 | 271 | " |
| Oil of Sesame | 20 | 1.39 | (Zalai, 1910.) |

**DICETYL** (Dotriacontane) $CH_3(CH_2)_{30}CH_3$.

The critical solution temperature of mixtures of dicetyl and sulfur dioxide is 110°. (Seyer and Todd, 1931)

Freezing-point data are given for mixtures of dicetyl and:

| | |
|---|---|
| Benzene(1) | Dodecane(1) |
| Butane(2) | Hexane(1) |
| Cyclohexane(1) | Octane(1) |
| Decane(1) | Propane(2) |

(1) Seyer, 1938; (2) Seyer and Fordyce, 1936.

## ACONITINE $C_{34}H_{45}NO_{11}$.

### Solubility of Aconitine in Water at 15°.
(Kolthoff, 1925.)

The author first determined the dissociation constant of aconitine. For this purpose the $p_H$ values were estimated colorimetrically for a 0.01 molecular solution of aconitine chloride to which increasing amounts of 0.01 normal Na OH were added. From this series of determinations the dissociation constant K, for aconitine was found to be $1.3.10^{-6}$.

The solubility product was next estimated by adding 0.1 cc. of 0.01 normal Na OH to 5.0 cc. of 0.01 molecular aconitine chloride solution, and after seeding, allowing to stand 24 hours. Only a very slight precipitation occurred and it was concluded that the aconitine was in equilibrium with a solution which was $8.10^{-3}$ normal with respect to aconitine chloride and had a hydroxyl ion concentration of $6.4.10^{-8}$ These values correspond to a solubility product of $5.10^{-10}$. The solubility is, therefore, $5.10^{-10} \div 1.3.10^{-6} = 4.10^{-4}$ or 260 milligrams aconitine per liter.

The author also states that he found a saturated solution of *Aconitine Nitrate* in water to have a concentration of $2.6.10^{-4}$ mol. per liter at 15°.

## ACONITINE (Amorphous) $C_{34}H_{47}NO_{11}$.

### Solubility in Several Solvents.
(At 25° U.S.P.; at 18°–22°, Müller — Apoth.-Ztg. 18, 2, '03.)

| Solvent. | Gms. $C_{34}H_{47}NO_{11}$ per 100 Gms. Solvent at: 18°–22°. | 25°. | Solvent | Gms. $C_{34}H_{47}NO_{11}$ per 100 Gms. Solvent at: 18°–22°. | 25°. |
|---|---|---|---|---|---|
| Water . . . | 0.054 | 0.031 | Benzene . . . . . | .. | 17.85 |
| Alcohol . . | ... | 4.54 | Carbon Tetrachloride | 1.99 | ... |
| Ether . . . | 1.44 | 2.27 | Petroleum Ether . . | 0.023 | 0.028 |

100 gms. $H_2O$ dissolve 0.0226 gm. aconitine at 22° (Dunstan and Umney, 1892.)
" " abs. alcohol " 2.7 " " " " " (Jürgens, 1885.)
" " " ether " 1.56 " " " " "

## INULIN $(C_6H_{10}O_5)_6.H_2O$.

### Solubility of Inulin in Water.
(Yanovsky and Kingsbury, 1933.)

The saturated solutions were prepared by intermittent shaking by hand and analyzed on successive days for reducing sugars and inulin. Equilibrium was approached very slowly. The results indicate that inulin from the dahlia and from chicory each exist in two modifications. One of the modifications of chicory inulin is unstable and gradually changes to the less soluble form.

| Source of Inulin | Gms. Inulin dissolved per 100cc solution at: 6° | 20° | 39° |
|---|---|---|---|
| Dahlia Inulin | 0.02 | 0.15 | 0.48 |
| " " (1) | — | 0.03 | — |
| Chicory Inulin | 0.49 | 0.76 | 3.0 |
| " " (1) | — | 0.12 | — |

(1) Recrystallized from water.

**XANTHALINE** (Mono) **PICRATE** (m. pt. 212°.5). $C_{37}H_{36}N_2O_9.HOC_6H_3(NO_2)_3$.

100 gms. sat. solution of Xanthaline Picrate in water contain 0.01 gm. of the compd. at 15°.

100 gms. sat. solution of Xanthaline Picrate in abs. alcohol contain 0.022 gm. of the compd. at 15°.

100 gms. sat. solution of Xanthaline Picrate in acetone contain 0.34 gm. of the compd. at 15°. (Maplethorpe and Evers, 1925.)

**LECITHIN** $C_{42}H_{84}NPO_9$.

100 gms. of sat. solution in aqueous 5% bile salts contain 4.5 gms. lecithin at 15°–20° and 7 gms. at 37°. Lecithin is practically insoluble in water. (Moore, Wilson and Hutchinson, 1909.)

SOLUBILITY OF LECITHIN IN AQUEOUS ETHYL ALCOHOL.

(Vita and Bracaloni, 1934.)

The saturated solutions were prepared by intermittent agitation and analyzed by evaporation and weighing the residues dried at 100°. The sample of lecithin was prepared from egg yolk and contained 2.06% N and 3.94% P.

| Vol. % $C_2H_5OH$ in solvent | Gms. Lecithin dissolved per 100cc alcoholic solution at : | | | | |
|---|---|---|---|---|---|
| | -15° | -4° | 0° | +7° | +15° |
| 75.84 | 1.27 | 1.32 | 1.34 | 1.62 | 2.14 |
| 79.91 | 1.96 | 2.03 | 2.15 | 2.96 | 4.08 |
| 82.75 | 2.85 | 3.16 | 3.47 | 5.36 | 9.04 |
| 85.31 | 4.11 | 5.15 | 5.60 | 9.35 | 27.05 |
| 86.95 | 6.05 | 8.43 | 9.49 | 19.08 | 46.91 |
| 87.92 | 8.51 | 11.82 | 13.67 | 50.03 | 54.52 |
| 88.86 | 10.86 | 13.48 | 19.60 | 52.92 | — |
| 92.15 | 22.43 | 29.15 | 42.58 | — | — |

**SOLANINE** $C_{52}H_{93}NO_{18}$.

SOLUBILITY OF SOLANINE IN WATER AT 15°.

(Kolthoff, 1925.)

This alkaloid is extraordinarily insoluble. In order to determine its *dissociation constant*, the $p_H$ was measured colorimetrically in mixtures of 5 cc. of 0.0108 *n* solanine chloride solution + 50-100 cc. of water + 0.54 to 2.7 cc. of 0.01 *n* Na OH. From these measurements it was calculated that $K = 2.2.10^{-7}$. For the determination of the *solubility product* it was found that a mixture of 5 cc. of 0.0108 *n* solanine chloride solution, 50 cc. of water and 0.5 cc. of 0.01 *n* Na OH just gave a slight precipitate on standing. The $p_H$ of the solution was 6.0 and the calculated $(OH) = 6.4.10^{-9}$. From this the solubility product $L_{Solanine} = 6.4.10^{-12}$. Calculating from L and K the solubility of solanine in water corresponds to a concentration of $3.10^{-5}$ mol. or about 0.025 gm. per liter.

**ALOIN.**

Squires and Caines (1905) found the solubility of aloin in water at room temperature to be 0.83 gm. per 100 cc. and in 90% alcohol, 5.55 gms. per 100 cc.

According to Wester and Bruins (1914) 100 gms. trichloroethylene dissolve 0.013 gm. aloin at 15°.

**CARMINE.**

| | | | | | |
|---|---|---|---|---|---|
| 100 gms. $H_2O$ | dissolve | 0.13 | gm. carmine at | 20–25°. | (Dehn, 1917.) |
| " pyridine | " | 3.34 | gms. " " " | " | |
| " 50% aq. pyridine | " | 2.03 | " " " " | " | |

**HELIANTHIN** (Methyl Orange, Tropaeolin).

100 cc. $H_2O$ dissolve 0.0055 to 0.0225 gm. helianthin. (Dehn, 1917a.)
100 cc. pyridine dissolve 0.75 gm. helianthin. "
100 cc. 50% aq. pyridine dissolve 62.5 gms. helianthin. "
Results for other solvents and observations on the state of colored compounds in solution are given.

## DYES.

Data for the distribution of 12 dyes between water and isobutyl alcohol at 25°, are given by Reinders and Lely, Jr. (1912).

Data for the solubility of thirty new azo dyes similar to oil scarlet, in carbon tetrachloride and in toluene are given by May and Hunt, 1928.

Data for the solubility of yellow AB (benzene-azo-β Naphthylamine) and of scarlet X 9995 (benzene-azo-β Naphthol), in aqueous solutions of stable protective colloids (soap or other detergents) are given by McBain and Woo, 1938.

## FATS, OILS and WAXES.

### Critical Solution Temperatures of Fats and Oils in Glacial Acetic Acid.

(Grimme, 1919, 1920.)

When a solution of a fat in a suitable solvent cools, it is observed that at a given temperature, which depends both upon the solvent and the nature of the selected fat, a sudden cloudiness of the solution develops. The temperature at which this takes place is the Critical solution temperature. The author gives a review of previous work upon this determination and subjects the method to a critical study. He used glacial acetic acid instead of alcohol in order to be able to work with open tubes instead of closed ones. He also tested the effect of cooling with and without an air bath. It was found that a bath of glycerol cooled so slowly that too much time was required for the determinations.

| Oil or Fat used. | Critical temperature of solution using: 1.0 part of oil +2.0 parts $CH_3COOH$. Without air bath. | 1.0 part of oil +2.0 parts $CH_3COOH$. With air bath. | 1.0 part of oil +1.0 part $CH_3COOH$. Without air bath. | 1.0 part of oil +1.0 part $CH_3COOH$. With air bath. |
|---|---|---|---|---|
| Apricot oil | 90.0 | 97.5 | 91.5 | 92.0 |
| Pea nut oil | 71.0 | 71.5 | 93.5 | 91.25 |
| Almond oil | 100.0 | 102.0 | 97.5 | 100.5 |
| Olive oil | 45.5 | 45.0 | 72.5 | 73.5 |
| Adansonia oil | 85.0 | 88.5 | 92.5 | 92.5 |
| Seed oil | 79.0 | 82.5 | 100.0 | 102.0 |
| Cotton seed oil | 87.5 | 80.0 | 96.5 | 96.75 |
| Rape seed oil | 104.0 | 104.0 | 98.5 | 96.5 |
| Sesame oil | 86.5 | 87.5 | 96.5 | 95.0 |
| Rice oil | 85.5 | 85.0 | 89.0 | 88.0 |
| Wood oil | 85.0 | 81.5 | 94.5 | 97.5 |
| Flax seed oil | 93.0 | 92.0 | 102.5 | 102.0 |
| Indian laurel oil | 52.0 | 51.5 | 61.5 | 61.5 |
| Marotti oil | 72.0 | 84.5 | 88.5 | 87.0 |
| Palm oil (Kamaroon) | 76.0 | 78.0 | 87.0 | 87.0 |
| " " (Togo) | 77.0 | 74.5 | 88.5 | 85.5 |
| Cocoa butter | 66.0 | 62.0 | 65.5 | 68.0 |
| " " | 64.0 | 63.0 | 69.0 | 68.5 |
| " " (old) | 66.0 | 62.5 | 70.5 | 65.0 |
| Cocoa nut fat | 39.0 | 44.5 | 60.0 | 60.0 |
| Butter fat | 64.0 | 65.0 | 68.5 | 68.0 |
| Cod liver oil | 79.5 | 78.5 | 88.5 | 86.5 |
| Beef tallow | 80.5 | 79.5 | 96.0 | 97.5 |
| Hog lard | 94.0 | 94.0 | 94.0 | 95.0 |

SOLUBILITY OF THE FATTY ACIDS OBTAINED FROM SEVERAL SOURCES IN ALCOHOL AND IN BENZENE. (Dubois and Pade, 1885.)

| Crude Fatty Acid of: | Gms. Fat per 100 Gms. Abs. Alcohol at: 0°. | 10°. | 26°. | Gms. Fats per 100 Gms. Benzene at 12°. |
|---|---|---|---|---|
| Mutton | 2.48 | 5.02 | 67.96 | 14.70 |
| Beef | 2.51 | 6.05 | 82.23 | 15.89 |
| Veal | 5 | 13.78 | 137.10 | 26.08 |
| Pork | 5.63 | 11.23 | 118.98 | 27.30 |
| Butter | 10.61 | 24.81 | 158.2 | 69.61 |
| Margarine | 2.37 | 4.94 | 47.06 | 13.53 |

MISCIBILITY OF FATS AND 90 VOL. PER CENT ALCOHOL AT 37°. (Vandevelde, 1911.)

Mixtures of fats and alcohol in various proportions were shaken twice daily for 8 days and the volume of each layer, as well as its composition, determined.

| Mixture. | Composition of Mixture: cc. Alcohol | cc. Fat | Volume after Agitation. cc. Alcohol | cc. Fat | Gms. Fat per 100 Gms. Alcohol Layer | Gms. Alcohol per 100 Gms. Fat Layer. |
|---|---|---|---|---|---|---|
| Alcohol + Cocaline | 25 | 5 | 25.4 | 4.6 | 4.9 | 19.4 |
| " " | 20 | 10 | 19.2 | 10.8 | 5.6 | 16.2 |
| " " | 15 | 15 | 13 | 17 | 7.2 | 13.5 |
| " " | 10 | 20 | 6.7 | 23.3 | 9.1 | 12.2 |
| " " | 5 | 25 | 1.1 | 28.9 | 13 | 11.4 |
| Alcohol + Butter Fat | 25 | 5 | 25.1 | 4.9 | 3.5 | 17.4 |
| " " | 20 | 10 | 19.2 | 10.8 | 3.5 | 14.1 |
| " " | 15 | 15 | 13 | 17 | 4 | 14.1 |
| " " | 10 | 20 | 7.1 | 22.9 | 5.7 | 11.4 |
| " " | 5 | 25 | 2 | 28 | 14.1 | 9.5 |
| Alcohol + Olive Oil | 25 | 5 | 24.7 | 5.3 | 2.3 | 11.2 |
| " " | 20 | 10 | 19.2 | 10.8 | 2.4 | 8.7 |
| " " | 15 | 15 | 13 | 17 | 2.4 | 8.7 |
| " " | 10 | 20 | 7.5 | 22.5 | 2.5 | 8.8 |
| " " | 5 | 25 | 2.2 | 27.8 | 7 | 7.6 |

For other data on the solubility of fats see Ewers (1910) and Louise (1911).

SOLUBILITY OF COCOANUT AND PALM KERNAL OIL IN ALCOHOL AND IN ACETIC ACID
(Van Kregten, 1919, 1920.)

| Solvent. | Per cent Concentration of solvent. | Critical solution temp. for Cocoa nut oil. | Palm kernal oil. |
|---|---|---|---|
| Ethyl Alcohol of $d_{\frac{15}{15}} = 0.7942$..... | 99.96 | 20.2 | 28.7 |
| " " " $= 0.7981$..... | 99.16 | 30 | 38.8 |
| " " " $= 0.8001$..... | 98.75 | 35.5 | 44.2 |
| " " " $= 0.8020$..... | 98.36 | 39.5 | 47.9 |
| Acetic Acid " $= 1.0573$..... | 99.05 | 17.9 | 32.5 |
| " " " $= 1.0579$..... | 99.05 | 26.0 | 41.5 |
| " " " $= 1.0584$..... | 98.85 | 30.9 | 46.5 |

1 gm. of oil + 5 cc. of solvent were employed for each determination. The cocoanut oil contained 0.032 %, of fatty acids and the palm kernel oil, 0.060 per cent. The critical solution temperatures of various mixtures of the two oils are also given.

SOLUBILITY OF SEVERAL OILS IN ALCOHOL ($d_{15} = 0.795$) AT 14–15°.
(Davidsohn and Wrage, 1915.)

| Oil. | Gms. Oil per 100 Gms. Sat. Sol. |
|---|---|
| Linseed Oil | 3.32 |
| Rape Oil | 1.36 |
| Cotton Seed Oil | 3.61 |
| Olive Oil | 2.25 |

Results are also given for the solubility of mixtures of oils and fatty acids in alcohol. The following results at 22°, in terms of approx. volume of oil dissolved by 100 volumes of 80% alcohol, are given by Aubert (1902). Nigella oil, 4.3; oil of boldo leaves, more than 100; matico oil, about 20; cascarilla oil, 5; weld-mint oil, 66.

Miscibility curves for various oils with acetone, petroleum and aniline are given by Louise (1911). The use of this data for the identification of oils and the detection of adulterants in them is described.

100 gms. anhydrous formic acid dissolve 0.77 gm. cotton seed oil at 25°.
(Gordon and Reid, 1922.)

Results for the solubility temperatures of separation of mixtures of Castor Oil (alone and containing up to 10% of Sesame oil) and 89.9 Vol.% Ethyl alcohol are given by Meerburg, 1929.

Data showing the miscibility at 25° of 90% and of absolute Ethyl Alcohol with the following oils; almond, apricot kernel, China wood, cod liver, corn, linseed, neat's foot, olive, peach kernel, rape seed, sesame, soy bean, sunflower, walnut and whale, are given by Taylor, Larson and Johnson, 1936.

Data for the reciprocal solubility of sulfonated castor oil, mineral oil and oleic acid are given by Hart, 1929.

### Solubility of Several Volatile Oils in Aqueous Alcohol at 22-25°.

(Wood, 1920.)

The determinations were made by gradually adding water to an alcoholic solution of the oil untill opalescence appeared. Since the volatile oils are mixtures the results are of only approximate accuracy.

| Per cent concentration of alcohol. | Cc. of each oil (determined separately), soluble in 100 cc. of alcohol of the concentration shown in the first column. | | | | | |
|---|---|---|---|---|---|---|
| | Anise oil. | Cinnamon oil. | Clove oil. | Eugenol. | Peppermint oil. | Sassafras oil. |
| 30 | 0.05 | – | 0.02 | – | 0.02 | 0.07 |
| 40 | 0.08 | – | 0.10 | 0.30 | 0.02 | 0.10 |
| 50 | 0.10 | 0.20 | 0.40 | 5.8 | 0.03 | 0.20 |
| 60 | 0.25 | 0.40 | 2.0 | 16.0 | 0.06 | 1.30 |
| 65 | 0.80 | 1.10 | 10.0 | – | 0.07 | 2.30 |
| 70 | 1.50 | 2.20 | 21.75 | – | 0.10 | 4.00 |
| 75 | 4.00 | 7.0 | – | – | 0.17 | 7.00 |
| 80 | 7.5 | – | – | – | 0.35 | 11.00 |

### Reciprocal Solubility of Several Oils and Fats in Liquid Sulfur Dioxide.

(Weisz and Opalski, 1922.)

Mixtures of weighed amounts of the oils and sulfur dioxide were sealed in high pressure glass tubes and the temperatures determined at which the mixture just became homogeneous or just showed a faint clouding. The sulfur dioxide contained 98.85 % $SO_2$ + 0.56 % $H_2O$ + 0.67 % oily residue.

Castor oil + $SO_2$.

| t° of demixing. | Per cent oil in mixture. |
|---|---|
| -19.... | 2.05 |
| - 8.... | 7.23 |
| -11.5.. | 28.74 |
| -21.0.. | 54.31 |
| -21.5.. | 63.04 |
| -22.... | 86.82 |

Lin seed oil + $SO_2$.

| t° of demixing. | Per cent oil in mixture. |
|---|---|
| - 6.25.. | 2.99 |
| + 0.5... | 7.79 |
| - 2.0... | 22.49 |
| - 6.75.. | 37.79 |
| -14.0... | 64.50 |
| -16.0.. | 70.85 |

Rape seed oil + $SO_2$.

| t° of demixing. | Per cent oil in mixture. |
|---|---|
| 39.75.. | 4.41 |
| 45.5... | 10.94 |
| 44.5... | 26.22 |
| 18.0... | 47.56 |
| 7.75.. | 52.17 |
| ± 0.0... | 80.34 |

Olive oil + $SO_2$.

| t° of demixing. | Per cent oil in mixture. |
|---|---|
| 28.5.. | 7.95 |
| 34.0.. | 11.12 |
| 8.5.. | 47.86 |
| -21.5.. | 79.07 |

Tallow + $SO_2$.

| t° of demixing. | Per cent tallow in mixture. |
|---|---|
| 21.75.. | 1.10 |
| 43.75.. | 10.97 |
| 25.5... | 43.07 |

Bone oil + $SO_2$.

| t° of demixing. | Per cent oil in mixture. |
|---|---|
| 15.5.... | 1.87 |
| 35.75... | 25.72 |
| 28.75... | 37.64 |

Oleic acid + $SO_2$.

| t° of demixing. | Per cent oleic acid in mixture. |
|---|---|
| 14..... | 4.43 |
| 22..... | 9.84 |
| 22.5.... | 18.26 |

Stearin + $SO_2$.

| t° of demixing. | Per cent stearin in mixture |
|---|---|
| 34..... | 6.72 |
| 37..... | 8.86 |
| 37.5... | 13.82 |

It is ponited out by Fontein, 1923, that the $H_2O$ in the $SO_2$ used, affects the temperature of demixing.

An extensive series of observations on the solubility of water in oils and on the water content of various oils is given by Umney and Bunker (1912).

Freezing-point data for oil of helianthus annus + stearic acid are given by Fokin (1912).

**WAXES**

Diagrams and numerical data are given by Pickett, 1929 for the solubility of Bees wax, Candelilla wax, Carnauba wax and Montau wax, each separately, in naphtha, turpentine, No. 22 thinner, (terpene hydro carbons + gasoline) solvenol (terpene hydro carbons + saturated hydro carbons), pine oil, sulfonated castor oil and mixtures of pine oil and sulfonated castor oil.

The effect of variations in precedure upon the solubility of Shellac in diethyl ether is reported by Gardner and Harris, 1934, and used as an illustration of the misleading results which are obtained unless precautions are taken to avoid important sources of error.

**GASOLINE** (Petrol. Essence) See also Heptane and Hexane.

Solubility of Motor Gasoline (66° Be) and Casing Head Gasoline (81° Be) in Water at 25°. (Milligan, 1924.)

Gasoline vapor mixed with air was shaken for 2 minutes with distilled water previously saturated with air. The mixture was analyzed by means of a Haldane gas analysis apparatus before and after contact with water, and the amount of gasoline dissolved by the water found by difference. The solubility coefficient $\alpha_{25}$ represents the volume of gas (reduced to 0°) which dissolves in one volume of water at 25° when the pressure of the gas over the water is 760 mm.

Using motor gasoline (66° Be) of average composition $C_7H_{16}$ (Heptane) the result was $\alpha_{25} = 0.017$.

Using casing head gasaline (81° Be) of average composition $C_6H_{14}$ (Hexane) the result was $\alpha_{25} = 0.012$.

From these values for gasoline vapors, corresponding in composition to heptane and hexane, the solubility of liquid heptane and hexane in water at 25° was calculated to be approximately 0.0007 and 0.0014 volumes, respectively, per 100 volumes of $H_2O$.

Solubility of Mixtures of Gasoline and Benzene and of Gasoline and Xylene in 92 wt. per cent Ethyl Alcohol at 20°. (Ormandy and Craven, 1921.)

| Gasoline + Benzene Mixtures. | | Gasoline + Xylene Mixtures. | | | |
|---|---|---|---|---|---|
| Vol. % $C_6H_6$ In mixture. | Gms. mixture per 100 gms. sat. sol. in 92 wt. % alcohol. | Vol. % $C_6H_4(CH_3)_2$ In mixture. | Gms. mixture per 100 gms. sat. sol. in 92 wt. % alcohol. | Vol. % $C_6H_4(CH_3)_2$ In mixture. | Gms. mixture per 100 gms. sat sol. in 92 wt. % alcohol. |
| 15 | 63.4 | 0.0 = Gasoline | 37.3 | 55.6 | 77.6 |
| 30 | 81.4 | 7.7 | 42.5 | 62.5 | 79.0 |
| 40 | 84.9 | 25.0 | 63.1 | 71.4 | 80.2 |
| 50 | 87.3 | 33.3 | 70.0 | 76.9 | 80.9 |
| 60 | 88.3 | 41.7 | 73.7 | 83.3 | 81.4 |
| 80 | 90.3 | 45.4 | 74.8 | 90.0 | 82.3 |
| 100 | 93.1 | 50.0 | 76.2 | 100.0 | 84.6 |

Similar results for mixtures of ether and xylene and ether and kerosene are also given.

**PETROLEUM ETHER.**

100 cc. $H_2O$ dissolve 0.005 cc. petroleum ether at 15°. (Groschuff, 1910.)

**LIGRÖIN.**

100 cc. $H_2O$ dissolve 0.341 cc. ligröin at 22°, Vol. of solution = 100.34, Sp. Gr. 0.9969.

100 cc. ligröin dissolve 0.335 cc. $H_2O$ at 22°, Vol. of solution = 100.60, Sp. Gr. 0.6640.

(Herz, 1898)

## PETROLEUM

Qualitative data upon the miscibility of samples of Pennsylvania and Texas petroleum oil and of paraffin wax with 27 solvents at 10°, 21°, and higher temperatures are given by Poole, 1929. Similar results for an additional 26 solvents are given by Poole and others, 1931. These and many quantitative results show that the number of solvents which may be used for dewaxing is very large.

Quantitative results are given by Poole, 1929, for the solubility of lubricating oils and of paraffin wax in acetone, butanol, ethyl acetate, butyl acetate, chloro benzene and toluene.

Quantitative determinations of the solubility of Pennsylvania petroleum and of paraffin wax in naphtha, turpentine, ethylene dichloride, methyl ethyl ketone, n butyl aldehyde, iso propyl alcohol, n amyl alcohol, alcohol, pentasol and paraldehyde, as well as results showing the effect of petroleum oil upon the solubility of paraffin wax in butanol, butyl acetate and chloro benzene are given by Poole and others, 1931. The results are useful in permitting the separation of paraffin wax from liquid hydro carbons by solubility differences.

Results showing the effect of temperature and of oil-solvent ratio upon the solubility of paraffin wax in butyl formate, n butyl aldehyde and diethyl carbinol are given by Poole and Mangelsdorf, 1932.

### Solubility of Petroleum in Liquid Sulfur Dioxide.

(Zerner, Weisz and Opalski, 1922.)

Mixtures of known amounts of the two products were sealed in resistance glass tubes and the temperatures determined at which a homogeneous mixture or slight clouding occurred. The $SO_2$ consisted of 98.85 % $SO_2$, 0.56 % $H_2O$ and 0.67 % oily residue. The petroleum was an American commercial sample which began to boil at 175°; 30.9 % distilled at 175°-200°, 47.9 % at 200°-225° and 15.6 % at 225°-250°. The $d_{18} = 0.8102$ and $n\frac{15°}{D} = 1.4514$.

| t° of Demixing. | Per cent Petroleum. | t° of Demixing. | Per cent Petroleum. | t° of Demixing. | Per cent. Petroleum |
|---|---|---|---|---|---|
| —12.6.... | 0.6 | 44.0... | 22.10 | 13.25.... | 73.6 |
| +13.0.... | 2.40 | 43.0... | 29.3 | − 3.0. .. | 79.0 |
| 24.5.... | 4.23 | 38.5.... | 48.4 | −20.5. .. | 85.1 |
| 36.0. . | 8.54 | 34.25... | 56.5 | −23.5. .. | 86.2 |
| 39.75... | 11.14 | 28.0.... | 63.6 | | |

The solutions were colored yellow to brown. At lowest concentrations of $SO_2$ a brown resin separates.

The above experiments are criticised by Fontein, 1923 who points out that the water present in the $SO_2$ affects the temperature of demixing.

The use of sulfur dioxide in the refining of petroleum is discussed in detail by Edeleanu, 1923.

## PARAFFINS.

Data for the solubility of several samples of paraffin in a large number of solvents are given by Sachanen, 1925. The samples of paraffin varied in melting-point from 41°-42°, 53 1/2°-55°, 56°-57°, 57°-58 1/2 and 78°-80°. The solvents included benzine, kerosene, paraffin oil of several densities, machine oil, mazout (containing and free from paraffin) benzoin, abs. alcohol, methyl alcohol and iso amyl alcohol. In each case the solubility begins at less than 1 per cent at a temperature of 0° or less and rises very rapidly to 50 per cent or more with increase of temperature to about 50°.

## PARAFFINS

### Solubility of Paraffin Wax in Pure Hydrocarbons.

(Weber and Dunlap, 1928.)

The sample of paraffin wax was carefully recrystallized three times from benzene. That part which first crystallized was taken for the next crystallization each time. The final sample was about 25 percent of the original amount. This product undoubtedly contained several constituents. Its melting point was 56° and density at 20/40° = 0.775. The hydrocarbons were very carefully purified.

| Hydrocarbon | b.pt. | $d\ \frac{20}{4}^{\circ}$ | Gms. Paraffin dissolved per 100cc Hydrocarbon at: 0° | 5° | 10° | 15° | 20° | 25° |
|---|---|---|---|---|---|---|---|---|
| n Pentane | 36.1–36.3 | 0.631 | — | — | 5.11 | 6.94 | 9.53 | 17.16 |
| n Hexane | 68.9–69.2 | 0.661 | 2.77 | 3.69 | 4.81 | 6.07 | 8.31 | 10.23 |
| n Heptane | 98.2–98.4 | 0.684 | 1.37 | 2.18 | 3.55 | 5.06 | 7.18 | 14.36 |
| n Octane | 124.5–124.6 | 0.706 | 0.99 | 1.69 | 2.90 | 4.24 | 5.93 | 11.66 |
| Iso decane | 159.8–160.1 | 0.721 | — | 0.94 | 1.44 | 2.74 | 4.98 | 9.17 |

The curves of solubility of a commercial paraffin wax from mid-continent crude petroleum, and of several samples obtained by repeated fractionation of this paraffin, in petroleum ether and in a number of mid-continent petroleum oils of varying viscosities, are reported by Sullivan, McGill and French, 1927. It was found that the solubility of paraffin waxes increases as the melting point of the wax decreases. The solubility decreases with increasing viscosity of the solvent. These differences were found to be less at the lower temperatures.

Determinations of the solubility relations of commercially refined paraffin waxes in petroleum distillates are reported by Berne-Allen and Work, 1938. It was found that the average boiling-points of the petroleum fractions and the melting-points of the paraffin waxes are directly related to the molecular weights of the solvents and solutes respectively. An empirical equation was established to express the relationship between m. pt. of the wax, b. pt. of the solvent and the solution temperature equilibrium.

### Solubility of Ozokerite Paraffin of Melting Point 64°–65° and Sp. Gr. at 20° = 0.917 in Several Solvents at 20°

(Pawlewski and Filemonowicz, 1888.)

| Solvent. | Gms. Paraffin per 100 Gms. Solvent. | cc. Solvent. | Solvent. | Gms. Paraffin per 100 Gms. Solvent. | cc. Solvent. |
|---|---|---|---|---|---|
| Carbon Disulfide | 12.99 | ... | Acetone | 0.262 | 0.209 |
| Benzine, boiling below 75° | 11.73 | 8.48 | Ethyl Acetate | 0.238 | ... |
| Turpentine, b. pt. 158°–166° | 6.06 | 5.21 | " Alcohol | 0.219 | ... |
| Cumol, com. b. pt. 160° | 4.26 | 3.72 | Amyl Alcohol | 0.202 | 0.164 |
| " frac. 150°–160° | 3.99 | 3.39 | Propionic Acid | 0.165 | ... |
| Xylene, com. b. pt. 135°–143° | 3.95 | 3.43 | Propyl Alcohol | 0.141 | ... |
| " frac. 135°–138° | 4.39 | 3.77 | Methyl Alcohol | 0.071 | 0.056 |
| Toluene, com. b. pt. 108°–110° | 3.88 | 3.34 | Methyl Formate | 0.060 | ... |
| " frac. 108°–109° | 3.92 | 3.41 | Acetic Acid | 0.060 | 0.063 |
| Chloroform | 2.42 | 3.61 | " Anhydride | 0.025 | ... |
| Benzene | 1.90 | 1.75 | Formic Acid | 0.013 | 0.015 |
| Ethyl Ether | 1.95 | ... | Ethyl Alcohol 75% | 0.0003 | ... |
| Isobutyl Alcohol, com. | 0.285 | 0.228 | | | |

Freezing-point data for mixtures of paraffin and naphthalene and paraffin + stearin are given by Palazzo and Battelli (1883).

### Solubility of Cellulose Esters in Various Organic Solvents.

(Mardles, 1923.)

"Cellulose esters dissolve in numerous organic liquids to form clear, viscous, colloidal solutions, from which the ester can be recovered unchanged. Some liquids appear to be better solvents than others, dissolving the cellulose acetate more rapidly and yielding less viscous solutions. Similarly a mixture of liquids often forms a better solvent than either taken singly." Saturation cannot be obtained in the ordinary way on account of the rapid rise of viscosity with concentration. The author has chosen a method based upon the observation of Schützenberger (*Compt. rend.*, 68, 814, 1869) that the triacetate of cellulose dissolves in nitrobenzene on warming and precipitates in a gelatinous form on cooling the solution. "The method of observing this transition temperature of the dispersion medium, from a complete solvent to a partial or non-solvent, has been used to appraise the relative solvent powers of liquids for cellulose esters. The point of precipitation is marked by the appearance of turbidity or opalescence, as in the case when a mixture of liquids is cooled below the temperature of complete miscibility, indicating the transition from a true solution to a coarse dispersion." About 5 cc. of a solution of a concentration of 5 grams per 100 cc., contained in a test-tube, was cooled with stirring, and the temperature noted at which opalescence appeared.

Results for Cellulose Acetate (Rhone).

| Solvent. | t° of opalescence for a concentration of 5 gm. per 100 cc. |
|---|---|
| Benzyl alcohol | 25° |
| » | 35 |
| Cyclo hexanol | 95 |
| *o* Methyl cyclo hexanol | 109 |
| *p* Methyl cyclo hexanol | 115 |
| *m* Methyl cyclo hexanol | 123 |
| Cyclohexanone | −17 |
| Cresyl acetate | 42 |
| Phenyl acetate | 33 |
| Tolyl alcohols | 47 |

Results for $(C_{12}H_{13}O_8Cl_3)_x$, believed to be Cellulose Chlor Acetate.

| Solvent. | t° of opalescence. for a concentration of 5 gm. per 100 cc. |
|---|---|
| Amyl benzoate | 90° |
| Benzyl alcohol | 57 |
| Tolyl alcohols | 75 |
| Methyl butyrate | less than −65 |
| Tolyl ethyl ethers | 110 |
| Cresyl methyl ethers | 125 |
| Tolyl methyl ethers | 70 |
| Amyl acetate | −60 |
| Diacetone alcohol | 27 |

Cellulose nitroacetate in benzyl alcohol (5 gm. per 100 cc.) gives opalescence at 25° and at higher temperatures, depending upon the nitrogen content of the sample.

The author found that for very dilute solutions the temperature of opalescence rises with concentration, but eventually remain nearly constant over a wide range of concentration, and then falls with further increase.

Data for the solubility in binary and ternary systems of solvents are also given

An indirect method of determining the solubility consists in comparing the effect upon various solvents of the addition of different amounts of an indifferent miscible non-solvent, such as petroleum ether, upon the temperature of precipitation of the cellulose ester. The non solvent, which was usually the heptane fraction of petroleum spirit, was added from a buret to about 5 cc. of the solution (of 5 gms. per 100 cc.) contained in a test-tube kept at 20°, untill the incipient turbidity persists. An extensive series of such measurements is given.

**NITROCELLULOSE** (Soluble Pyroxylin, Tetra and Penta Nitrate).

SOLUBILITY IN ETHER-ALCOHOL MIXTURES.

(Matteoschat, 1914; see also Stepanow, 1907.)

A sample of gun cotton containing 12.95% N was used. The compound was first covered with alcohol and then the amount of ether to yield the desired composition of solvent was added. Lower results were obtained with ready prepared ether-alcohol mixtures.

| Ratio of Ether : Alcohol. | Gms. Gun Cotton Dissolved per 100 Gms. Solution in Mixtures Prepared with: | | | |
|---|---|---|---|---|
| | 99.5 Vol. % Alcohol. | 95 Vol. % Alcohol. | 90 Vol. % Alcohol. | 80 Vol. % Alcohol. |
| 1 : 2 | 34.4 | ... | ... | ... |
| 1 : 1 | 52.3 | 42.3 | 28.7 | 14.2 |
| 2 : 1 | 40.5 | 52.4 | 53.9 | 45 |
| 3 : 1 | 25 | 42.4 | 53 | 57.5 |

**NITROCELLULOSE.**

Experiments upon the solubility of nitrocellulose in mixtures of alcohol and ether are described by de Bruin, 1921, and in mixtures of alcohol and ethylacetate by Wilkie, 1921. It was found by de Bruin that the solubility decreased as the per cent of nitrogen in the sample increased. 384 samples were tested with the following results.

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Mean per cent of N.. | 11.38 | 12.25 | 12.45 | 12.64 | 12.74 | 12.85 | 12.93 | 13.19 |
| Mean solubility..... | 97.5 | 95.6 | 85.6 | 66.8 | 48.2 | 34.3 | 23.8 | 8.2 |

The exact terms in which the results are given are not-stated. The solvent consisted of approximately 33 vol. per cent $C_2H_5OH$ and 66 vol. per cent $(C_2H_5)_2O$. It was found by Wilkie that four different samples of nitrocellulose each showed a slight maximum solubility in a mixture of about 60 per cent ethyl acetate in alcohol, but the differences between the several samples were greater than the variations in solubility of any sample in increasing concentrations of ethyl acetate in alcohol.

**TURPENTINE OIL**

SOLUBILITY IN ETHYL ALCOHOL.

(Vezes and Mouline, 1904, 1905–06.)

Spirit of turpentine and absolute alcohol are miscible in all proportions and the mixture may be cooled to a very low temperature without ceasing to be homogeneous. In the case of alcohol containing a small amount of water, the mixture, which is uniform at ordinary temperature, separates into two layers when cooled. The following data were obtained for mixtures of 98 vol. % alcohol (= 0.968 gm. $C_2H_5OH$ per 1 gm. aq. alcohol) and spirits of turpentine and for mixtures of 95 vol. % alcohol (= 0.924 gm. $C_2H_5OH$ per 1 gm. aq. alcohol) and spirits of turpentine.

| Results for 98 Vol. % Alcohol. | | | | Results for 95 Vol. % Alcohol. | | | |
|---|---|---|---|---|---|---|---|
| t° of Separation. | Gms. 98 Vol. % Alcohol per 100 Gms. Mixture. | t° of Separation. | Gms. 98 Vol. % Alcohol per 100 Gms. Mixture. | t° of Separation. | Gms. 95 Vol. % Alcohol per 100 Gms. Mixture. | t° of Separation. | Gms. 95 Vol. % Alcohol per 100 Gms. Mixture. |
| −35.6 | 2.7 | −20.9 | 32.9 | +20.7 | 2.4 | 29.6 | 48.3 |
| −23 | 4.8 | −26.1 | 42.6 | 42.2 | 3.4 | 23.9 | 52.8 |
| −20.9 | 9.5 | −30 | 48.2 | 53 | 7.2 | 16.3 | 61.4 |
| −18.1 | 13.2 | −45.3 | 58 | 53.1 | 10.2 | −15.5 | 76.6 |
| −17.8 | 16 | −79.2 | 71.9 | 44 | 20.3 | −24 | 81.1 |
| −18.8 | 24.4 | | | 37.2 | 30.6 | −63 | 87.1 |

Data in regard to the sample of spirits of turpentine which was used, are not given.

## CAOUTCHOUC.

SOLUBILITY IN ORGANIC SOLVENTS. (Hanausek, 1887.)

| Solvent. | Gms. Caoutchouc Dissolved per 100 Gms. Solvent. | | |
|---|---|---|---|
| | Ceara. | Tete Noire. | Sierra Leone. |
| Ether | 2.5 | 3.6 | 4.5 |
| Turpentine | 4.5 | 5 | 4.6 |
| Chloroform | 3 | 3.7 | 3 |
| Petroleum | 1.5 | 4.5 | 4 |
| Benzene | 4.4 | 5 | 4.7 |
| Carbon Disulfide | 0.4 | 0 | 0 |

SOLUBILITY OF CAOUTCHOUC IN MIXTURES OF BENZENE AND ALCOHOL. (Caspari, 1915.)

(Freshly prepared solutions of deresinified caoutchouc in benzene were titrated with alcohol to appearance of two phases. The end point is sharp to within one drop of precipitant, especially at low concs. of caoutchouc. For purposes of converting the weights of caoutchouc to volume, the factor 0.91 may be taken.)

Results at 20°.

| Gms. Caoutchouc. | cc. $C_6H_6$. | cc. Abs. $C_2H_5OH$. | Gms. Caoutchouc | cc. $C_6H_6$. | cc. 95% $C_2H_5OH$. | Gms. Caoutchouc. | cc. $C_6H_6$. | cc. 92% $C_2H_5OH$. |
|---|---|---|---|---|---|---|---|---|
| 0.032 | 40 | 17 | 0.206 | 40 | 11 | 0.80 | 40 | 9.6 |
| 0.080 | 40 | 15.8 | 0.81 | 40 | 10.8 | 2.01 | 40 | 8.8 |
| 0.405 | 40 | 14.8 | 2.01 | 40 | 10.2 | 3.20 | 40 | 8.1 |
| 2.404 | 40 | 14.5 | 3.22 | 40 | 9.8 | | | |
| 4.061 | 40 | 13.8 | | | | | | |

Results at 40°.

| Gms. Caoutchouc. | cc. $C_6H_6$. | cc. Abs. $C_2H_5OH$. |
|---|---|---|
| 0.2 | 40 | 18.8 |
| 1.0 | 40 | 18.1 |
| 2 | 40 | 17.4 |

Results at 60°.

| Gms. Caoutchouc. | cc. $C_6H_6$. | cc. Abs. $C_2H_5OH$ |
|---|---|---|
| 0.2 | 40 | 21.6 |
| 1 | 40 | 23.3 |
| 2 | 40 | 24.4 |

SOLUBILITY OF CAOUTCHOUC IN MIXTURES OF BENZENE AND ACETONE. (Caspari, 1915.)

Results at 20°.

| Gms. Caoutchouc. | cc. $C_6H_6$. | cc. $(CH_3)_2CO$. |
|---|---|---|
| 0.11 | 20 | 15.7 |
| 0.80 | 20 | 15.0 |
| 1.86 | 20 | 14.7 |

Results at 40°.

| Gms. Caoutchouc. | cc. $C_6H_6$. | cc. $(CH_3)_2CO$. |
|---|---|---|
| 0.10 | 20 | 19.6 |
| 0.98 | 20 | 17.6 |

Results at 60°.

| Gms. Caoutchouc. | cc. $C_6H_6$. | cc. $(CH_3)_2CO$. |
|---|---|---|
| 0.10 | 20 | 23 |
| 1.01 | 20 | 26.4 |

The comparative qualitative solubility characteristics of caoutchouc balata, hydro caoutchouc, polysterols, polyvinyl acetate, poly iso propenyl methyl ketone and poly vinyl ester in $CS_2$, $CHCl_3$, $CCl_4$, $C_6H_6$, cyclohexane, hexane, tetralin, decalin, pyridine, ether, acetone dioxan, ethyl acetate, methyl alcohol and acetic acid, and for polystyrol and hydro polystyrol in most of the above solvents, are given by Steudinger and Heuer, 1934. The authors also give results for the precipitability of polystyrols of molecular weight 60,000 and 140,000 in various solvents, by the addition of methyl alcohol and of acetone, and the precipitability of a series of polystyrols of molecular weight 2400 to 250,000 dissolved in benzene and in methyl ethyl ketone, by the addition of methyl alcohol and of ethyl alcohol.

## EDESTIN.

### Solubility of Edestin in Aqueous Solutions at 25°. (Kodama, 1922.)

Crystalline edestin, prepared from hemp seed by the method of Osborne, was used. Into a series of flasks, 0.05 gm. edestin and 10 cc. portions of aqueous HCl or Na OH solutions of various concentrations were placed. The mixtures were kept in a thermostat at 25° for 30 minutes. The $p_H$ was determined by Clark's method. The mixtures were filtered and the dissolved edestin in the filtrates determined nephelometrically. The results show that edestin dissolves as the HCl salt in solutions more acid than $p_H$ 5.9 and as the Na OH salt in solutions more alkaline than $p_H$ 8.0. Between $p_H$ 5.9 and 8.0 the amount dissolved could not be detected by the nephelometric method. The iso electric point of edestin is at $p_H$ 5.9. Neutral Na Cl solutions dissolve edestin only when the concentration of Na Cl is greater than 2.0 normal and the acidity of the solution not more than $p_H$ 5.9.

## EDESTIN and Edestin Salts.

### Solubility in Aq. Salt Solutions at 25°.
(Osborne and Harris, 1905.)

The determinations were made by shaking an excess of the air-dry preparation with 20 cc. of the salt solution, allowing the globulin to settle and determining nitrogen in 10 cc. of the clear supernatant solution. The edestin or edestin salt was calculated from the N. The results are given in the form of curves. The following figures were read from the curve for the solubility of neutral edestin in aq. NaCl.

| | | | | | |
|---|---|---|---|---|---|
| Gms. NaCl per 20 cc. Solvent | → 0.468 | 0.585 | 0.702 | 0.818 | 0.935 |
| Gm. Edestin per 20 cc. Sat. Sol. | → 0.25 | 0.55 | 0.92 | 1.25 | 1.45 |

Curves are also given for the solubility of edestin in aqueous solutions of many other salts and of the solubility of edestin chloride, bichloride and sulfate in aq. sodium chloride solutions.

100 gms. pyridine dissolve 0.07 gm. edestin at 20–25°. (Dehn, 1917.)
100 gms. aq. 50% pyridine dissolve 9.05 gm. edestin at 20–25°. "

## ZEIN (Protein from Corn).

### Solubility in Aqueous Alcohol Solutions at 25°.
(Galeotti and Giampalmo, 1908.)

Dry powdered zein was added to the alcohol + water mixtures and the solutions kept at 25° and shaken frequently during 24 hrs. The removed undissolved residue was dried to constant weight and weighed.

| Vol. % $C_2H_5OH$ in Solvent. | Gms. Zein per 100 Gms. Sat. Sol. | Vol. % $C_2H_5OH$ in Solvent. | Gms. Zein per 100 Gms. Sat. Sol. |
|---|---|---|---|
| 10 | 0.05 | 60 | 18.57 |
| 20 | 0.11 | 70 | 19.87 |
| 30 | 0.21 | 80 | 7.81 |
| 40 | 0.51 | 90 | 4.51 |
| 50 | 1.43 | 100 | 0.02 |

Similar results are given for the solubility of zein in mixtures of $C_2H_5OH + H_2O + CHCl_3$ at 20° and $C_2H_5OH + H_2O +$ acetone at 25°.

# GLIADIN.

## Solubility of Gliadin in Aqueous Solutions of Acids at 25°.

(Tague, 1925.)

The gliadin was prepared from wheat flour by the method of Osborne. One gram per 100 cc. of aqueous acid, containing 5 drops of toluene, were constantly shaken for 8 hours. The mixture was allowed to stand over night and the nitrogen determined in 100 cc. of the clear filtrate. The factor 5.7 was used to convert nitrogen to gliadin.

| Normality of aq. acid solution. | Grams of Gliadin per 100 cc. of sat. solution in aq. | | |
|---|---|---|---|
| | H Cl. | $H_2SO_4$. | $CH_3COOH$. |
| 1.0 | 0.0550 | 0.0632 | 0.1733 |
| 0.1 | 0.0661 | 0.0741 | 0.1654 |
| 0.01 | 0.1397 | 0.1208 | 0.1309 |
| 0.001 | 0.1357 | 0.1265 | 0.1117 |
| 0.0001 | 0.0966 | 0.0890 | 0.0816 |
| 0.00001 | 0.0700 | 0.0716 | 0.0761 |

Since the method of preparation and purification has a great deal to do with the physical and chemical characteristics of proteins, the author determined the solubility in aqueous H Cl, of three samples of gliadin prepared by slight modifications of the method of preparation.

| Normality of aqueous H Cl. | Gms. Gliadin per 100 cc. sat. solution | | |
|---|---|---|---|
| | Sample N° 1. | Sample N° 2. | Sample N° 3. |
| 1.0 | 0.0496 | 0.0550 | 0.0442 |
| 0.1 | 0.0584 | 0.0600 | 0.0613 |
| 0.01 | 0.3554 | 0.1297 | 0.2428 |
| 0.001 | 0.3348 | 0.1254 | 0.1972 |
| 0.0001 | 0.1699 | 0.1083 | 0.0452 |
| 0.00001 | 0.0923 | 0.0938 | 0.0262 |

The author also gives data which show that :

Moist gliadin is about twice as soluble as dry gliadin.

The amount of gliadin dissolved varies directly with the amount of excess of solid material used for preparing the saturated solution. With 5.0 gms. per 100 cc of solvent there is from 3 to 4 times as much dissolved as when 1.0 gm. per 100 cc. is used.

The solubility increases with time of shaking up to about 72 hours.

The maximum solubility occurs at $p_H$ 2 to 3 and the minimum at $p_H$ 6.5.

Gliadin is slightly soluble in aqueous sodium carbonate solution, with maximum at about 0.009 molar.

The solubility in aqueous solutions of neutral salts is only about 0.001 gm. per 100 cc., except with $MgCl_2$ solutions, in which it may reach 0.084 gm. per 100 cc. in concentrated solutions.

Gliadin in quite soluble in aqueous methyl alcohol; the maximum being 0.1322 gms. per 100 cc. in alcohol of 70 volume per cent.

## Solubility of Gliadin in Aqueous Solutions of Ethyl Alcohol.

(Dill and Alsberg, 1925.)

Solutions of gliadin and the solvent in sealed tubes warmed to 50°, were cooled very gradually and the temperature observed at which turbidity appeared. For each solvent this temperature was practically independant of the gliadin concentration.

| Concentration of Gliadin in gms. per 100 gms solution. | Temp. of appearance of Turbidity in aq. Alcohol of | | |
|---|---|---|---|
| | 50 Vol. per cent. | 60 Vol. per cent. | 70 Vol. per cent. |
| 0.1 to 0.3 | −3° | −1° to −2° | 0° to −2° |
| 0.4 to 25.0 | +5° to +8° | −1° to +2° | +3° to +8° |

### Turbidity Temperatures of 2.5 per cent Gliadin Solutions in Aqueous Mixtures of Ethyl, Methyl and *n* Propyl Alcohols.

(Dill and Alsberg, 1925.)

Determinations were made with five different samples of gliadin, and for one of these samples, with the three different alcohols. In every case the amount of gliadin present was the same, namely, 2.5 gms. per 100 gms. of the solution.

| | Temperatures at which turbidity appeared in 2.5 per cent solutions of | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | | | Gliadin No. 3 A in | | |
| Vol. per cent of Alcohol. | Gliadin No. 1 in aq. $C_2H_5OH$ | Gliadin No. 2A in aq. $C_2H_5OH$. | Gliadin No. 2B in aq. $C_2H_5OH$. | Gliadin No. 3B in aq. $C_2H_5OH$. | aq. $C_2H_5OH$. | aq. $CH_3OH$. | aq. *n* $C_3H_7OH$. |
| 5.0 | — | — | — | — | 66 | 70+ | 70+ |
| 7.5 | — | — | — | — | 56 | 70 | — |
| 10.0 | — | — | — | — | 44 | 58 | 28 |
| 20.0 | — | — | — | — | 33 | 43 | 17 |
| 30 | 33 | 29 | 32 | 27 | 24 | 34 | 6 |
| 40 | 23 | 19 | 21 | 18 | 16 | 26 | —3 |
| 50 | 13 | 9.5 | 12 | 9 | 7.5 | 21 | —6.5 |
| 55 | 11 | 7 | 10 | 6.5 | 4 | — | —6 |
| 60 | 8.5 | 4.5 | 7.5 | 5.5 | 2 | 13 | —3 |
| 65 | 10 | 5.5 | 9 | 6 | 2.5 | 10 | — |
| 70 | 15 | 9.5 | 13 | 11 | 5 | 12 | 14 |
| 80 | 41 | 35 | 38 | 35.5 | 31 | 19 | 61 |
| 82.5 | — | — | — | — | 41 | — | 70+ |
| 85 | — | — | — | — | 55 | 29 | — |
| 90 | — | — | — | — | 70+ | 70+ | — |

« The phenomenon appears to be one of peptization rather than of true solution ».

The authors also give determinations of the solubility (peptization) of gliadin in aqueous solutions of other compounds. The results show the minimum concentration (mols. per liter) of each compound in water, capable of holding gliadin in solution at 20°, as determined by dilution. KSCN, 1.06; $NH_4SCN$, 1.09; KI, about 5.0; Urea, 2.03; $CH_3OH$, 12.1; $C_2H_5OH$, 5.8; *n* $C_3H_7OH$, 2.28; isopropyl alcohol, 4.7; chloral hydrate, 3.0.

## CASEIN.

The solubility of Casein in water at its iso electric point (pH 4.6) is 0.11 gms. per liter at 25°. (Cohn, 1922, 1923.)

### Solubility of Casein in Dilute Solutions of Sodium Chloride at 18-22°.

(Ryd, 1917.)

An accurately weighed amount of highly purified casein was dissolved in an accurately measured amount of $CO_2$ free Na OH solution, in an apparatus provided with an efficient stirrer and into which measured amounts of standard Na OH and HCl solutions could be introduced from burets. Provision was made to prevent the introduction of $CO_2$. An amount of H Cl equivalent to the Na OH present was added. If too much casein was present the opalescence and precipitation occurred before the neutral point was reached. If, on the other hand, too little casein was present more acid could be added than corresponded to the used amount of Na OH without causing opalescence. By alternate additions of Na OH and H Cl the point could finally be obtained where the last added drop of HCl just produced opalescence. A series of such determinations gave the following results :

| Mols NaCl. per liter. | Gms. Casein per liter. | Mols NaCl per liter. | Gms. Casein per liter. | Mols NaCl per liter. | Gms. Casein per liter. |
|---|---|---|---|---|---|
| 0.03653 | 0.64 | 0.11149 | 3.46 | 0.16054 | 1.87 |
| 0.06900 | 1.43 | 0.12308 | 3.37 | 0.17476 | 1.65 |
| 0.07944 | 1.86 | 0.12645 | 3.11 | 0.18525 | 1.55 |
| 0.09222 | 2.48 | 0.13111 | 2.97 | 0.20227 | 1.50 |
| 0.09250 | 2.68 | 0.13619 | 2.89 | 0.22839 | 1.40 |
| 0.10189 | 2.87 | 0.14688 | 2.52 | 0.23395 | 1.30 |
| 0.10643 | 3.24 | 0.15676 | 2.09 | 0.27245 | 1.32 |

The $p_H$ of the solutions varied between 5.05 and 5.52.

## Solubility of Acid Precipitated Casein in Aqueous Salt Solutions.

(McKee and Gould, 1938.)

The sample of casein was prepared by precipitating skim milk with HCl at a pH of 4.1. Since the solubility of casein varies with the excess present in contact with the sat. solution (thus showing the non-homogeneity of casein), all determinations were made with 5 gms. per 50cc of solution and 0.2% phenol was used to prevent bacterial decomposition. All determinations were made at pH 4.6, the iso electric point of casein. The amount of dissolved casein in the filtered saturated solution was determined by precipitation with acetic acid at 35-40°, allowing to stand over night, filtering, washing, drying and weighing.

| Aqueous salt solution | Gms. Casein dissolved per 100 gms. solvent at: 15° | 30° | 45° |
|---|---|---|---|
| 5.0% Sodium cymene sulfonate | 3.0480 | 5.9390 | 9.6753 |
| 7.5% " " " | 5.2999 | 8.0197 | — |
| 2.5% Potassium thiocyanate | 1.7850 | 2.5089 | 3.4201 |
| 5.0% " " | 3.5490 | — | — |
| 5.0% Sodium benzene sulfonate | 0.9778 | 1.9331 | 3.0486 |
| 10.0% " " " | 2.2070 | 2.7450 | 4.8202 |

## Solubility of Casein in Aqueous Solutions of Salts and Acids.

(von Euler and Bucht, 1923.)

An excess of casein was shaken with 50 cc. portions of the aqueous solutions for 2 or 4 hours. The temperature is not stated. The dissolved casein was determined by the addition of sodium acetate or acetic acid and filtering the precipitate and drying in a vacum over $H_2SO_4$, and then in an ordinary desiccator over solid Na OH.

| Solvent. | Concentration of solvent in mols per liter. | Gms. Casein dissolved per 50 cc. | Solvent. | Concentration of solvent in mols per liter. | Gms. Casein dissolved per 50 cc. |
|---|---|---|---|---|---|
| Aq. sodium tartrate.. | 0.005 | 0.0236 | Aq. chlor. acetic ac.. | 0.005 | 0.0523 |
| » .. | 0.010 | 0.0264 | » .. | 0.010 | 0.1399 |
| » .. | 0.020 | 0.0731 | » .. | 0.020 | 0.700 |
| » .. | 0.100 | 0.2544 | » .. | 0 050 | 1.0+ |
| Aq. tartaric acid.... | 0.0045 | 0.0480 | 50 % Aq. $C_2H_5OH$ sol. | | |
| » .... | 0.009 | 0.0943 | of chlor acetic acid.. | 0.002 | 0.0033 |
| » .... | 0.018 | 0.1608 | » .. | 0.005 | 0.0444 |
| » .... | 0.026 | 0.2173 | » .. | 0.010 | 0.0682 |
| » .... | 0.046 | 0.3363 | » .. | 0.020 | 0.0894 |

Results are also given for the solubility of casein in chlor acetic acid solutions in aqueous 42.6 % and 58.6 % $C_2H_5OH$. In these cases the amount of chlor acetic adsorbed by the undissolved casein was also determined. Similar experiments were also made with solutions of α brom propionic acid in aqueous 42.6 % $C_2H_5OH$, and a series of determinations was made with 0.1 normal monochlor acetic acid in 42.6 % aqueous $C_2H_5OH$ to which increasing amounts of casein were added.

100 gms. abs. alcohol dissolve 0.28 gm. casein at 20-25° (Pucher and Dehn, 1921.)
» quinoline » 0.38 » » » »
» equi molecular mixture of alcohol and quinoline dissolve 0.92 gms. casein at 20-25°.

100 gms. $H_2O$ dissolve 2.01 gms. casein at 20-25°. (Dehn, 1917.)
100 gms. pyridine dissolve 0.09 gm. casein at 20-25°. "
100 gms. aq. 50% pyridine dissolve 0.56 gm. casein at 20-25°. "

An abstract of experiments on the solubility of casein in dilute acids is given by Van Slyke and Winter (1913). Results for the solubility of casein in aqueous solutions of KOH, LiOH and $Ca(OH)_2$ at various temperatures, are given by Robertson, 1908.

## GELATIN

### Solubility of Gelatin in Water and in Aqueous Solutions of Acids and Bases at 15°-17°. (Fairbrother and Swan, 1922.)

One gram quantities of gelatin in 3/4 inch squares were place in conical flasks of 250 cc. capacity together with a few crystals of thymol and 100 cc. of the aqueous solution. The flasks were shaken gently once each day for ten days. The supernatant liquid was filtered through paper and the first two 20 cc. portions of filtrate were rejected. The third 20 cc. portion was neutralized, using methyl red as indicator. It was diluted to 40 cc. with $H_2O$ and 20 cc. of a 1 % solution of tannin were added The precipitate was kept at 0° for 1/2 hour, filtered upon a tared filter, washed with water to remove excess of tannin and then dried at 100° and at 105° and weighed. The method was controlled by means of determinations upon quantities of gelatin between 0.001 and 0.080 gm. per 20 cc. The sample of gelatin employed for the solubility determinations was Coignet's Gelatin Extra (Gold Label). It contained 2.24 % of ash, 16.7 % $H_2O$ and a 1 % solution had $p_H = 5.6$ at 20°.

Solubility in water :

| t° | 0°. | 15°-17°. | 18°.3. | 22°. |
|---|---|---|---|---|
| Gm. dry gelatin per 100 cc. sat. sol. | 0.02 | 0.05 | 0.07 | 0.10 |

Solubility in Aqueous Solutions of :

Hydrochloric Acid.

| Concentration of HCl mols. per liter | | Gm. Gelatin per 100 cc. final liquor. |
|---|---|---|
| Initial. | Final. | |
| 0.0002 | -- | 0.03 |
| 0.0010 | -- | 0.01 |
| 0.0020 | 0.0006 | 0.02 |
| 0.0050 | 0.0009 | 0.03 |
| 0.0067 | 0.0019 | 0.05 |
| 0.0100 | 0.0038 | 0.06 |
| 0.0200 | 0.0134 | 0.08 |
| 0.050 | 0.045 | 0.10 |
| 0.100 | 0.097 | 0.14 |
| 0.200 | 0.1986 | 0.24 |
| 0.500 | – | 1.00 (= all) |

Sulfuric Acid.

| Concentration of $H_2SO_4$ mols per liter | | Gm. Gelatin per 100 cc. final liquor. |
|---|---|---|
| Initial. | Final. | |
| 0.0000 | – | 0.06 |
| 0.0001 | – | 0.04 |
| 0.0005 | – | 0.03 |
| 0.0010 | 0.0002 | 0.04 |
| 0.0025 | 0.0005 | 0.07 |
| 0.005 | 0.0016 | 0.07 |
| 0.010 | 0.0063 | 0.09 |
| 0.025 | 0.0219 | 0.11 |
| 0.050 | 0.0472 | 0.14 |
| 0.100 | 0.0995 | 0.23 |
| 0.250 | – | 1.00 (= all) |

Nitric Acid.

| Concentration of $HNO_3$ mols. per liter | | Gms. gelatin per 100 cc. final liquor. |
|---|---|---|
| Initial. | Final. | |
| 0.0000 | — | 0.04 |
| 0.0002 | — | 0.05 |
| 0.0010 | — | 0.05 |
| 0.0020 | 0.0005 | 0.04 |
| 0.0051 | 0.0013 | 0.05 |
| 0.0100 | 0.0049 | 0.07 |
| 0.0205 | 0.0159 | 0.09 |
| 0.0512 | 0.0461 | 0.12 |
| 0.1024 | 0.0985 | 0.14 |
| 0.2048 | 0.2019 | 0.21 |
| 0.5125* | — | 1.00 (= all) |

Acetic Acid.

| Concentration of $CH_3COOH$ mols. per liter | | Gms. gelatin per 100 cc. final liquor. |
|---|---|---|
| Initial. | Final. | |
| 0.0002 | — | 0.05 |
| 0.0010 | — | 0.04 |
| 0.0020 | 0.0005 | 0.05 |
| 0.0050 | 0.0027 | 0.05 |
| 0.0100 | 0.0072 | 0.06 |
| 0.0200 | 0.0159 | 0.06 |
| 0.050 | 0.0401 | 0.06 |
| 0.100 | 0.0821 | 0.07 |
| 0.200 | 0.1675 | 0.09 |
| 0.500 | 0.429 | 0.14 |
| 5.000 | — | 1.00 (= all) |

* The gelatin in this solution gave a turbid red liquid probably due to the xanthoproteic reaction.

## Solubility of Gelatin at 15-17° in Aqueous Solutions of :

### Potassium Hydroxyde.

| Concentration of KOH mols. per liter | | Gms. gelatin per 100 cc. final liquor. |
|---|---|---|
| Initial. | Final. | |
| 0.0010 | — | 0.06 |
| 0.0050 | 0.0016 | 0.07 |
| 0.0062 | 0.0024 | 0.07 |
| 0.0100 | 0.0052 | 0.10 |
| 0.0125 | 0.0066 | 0.12 |
| 0.0211 | 0.0137 | 0.19 |
| 0.025 | 0.0178 | 0.21 |
| 0.050 | 0.0397 | 0.42 |
| 0.100 | — | 1.00 (= all) |

### Sodium Hydroxyde.

| Concentration of NaOH mols. per liter | | Gms. gelatin per 100 cc. final liquor. |
|---|---|---|
| Initial. | Final. | |
| 0.0000 | — | 0.05 |
| 0.0020 | — | 0.05 |
| 0.0050 | 0.0017 | 0.06 |
| 0.00625 | 0.0024 | 0.07 |
| 0.0100 | 0.0049 | 0.08 |
| 0.0125 | 0.0068 | 0.11 |
| 0.020 | 0.0135 | 0.18 |
| 0.025 | 0.0188 | 0.22 |
| 1.050 | — | 1.00 (= all) |

## Solubility of Gelatin in Water.

(Mardles, 1930.)

One gram portions of Coignet's best quality gelatin leaf were allowed to soak in 100cc of water at the several temperatures with occasional shaking, for a period of one to two days. The supernatant solution was analyzed by precipitation with 2% tannic acid solution and estimating the content of gelatin from the volume of the precipitate centrifuged under controlled conditions.

| t° | Gms. Gelatin per 100cc solution | t° | Gm. Gelatin per 100cc solution | t° | Gm. Gelatin per 100 cc solution |
|---|---|---|---|---|---|
| 10 | 0.030 | 24 | 0.200 | 28 | 0.725 |
| 15 | 0.055 | 26 | 0.630 | 29 | 0.725 |
| 20 | 0.080 | 27 | 0.700 | 30 | 0.870 |

At 26° and above the swollen gelatin broke into small fragments and there is a possibility that a part of it dispersed in the gelatin solution in the form of a suspensoid. The results show that at about 26° a rapid rise in solubility occurs.

Solubility determinations with amounts of gelatin other than one gram per 100 cc are markedly different. Thus with 0.1 gm. gelatin per liter at 15° the solubility was found to be 0.005 gm. per 100 cc and with 4.0 gms. of gelatin per 100 cc it was 0.160 gm. per 100cc. The previous experiments of Mellanby, 1905, of Cohn, 1922, and of Sorensen, 1925, on this property of proteins are described.

The author also gives results on the rate of solution of gelatin, its precipitation from solution with falling temperature and the influence of additions of organic compounds on its solubility.

The following results were obtained for the solubility of gelatin dissolved from one gram portions by 100cc of water containing alcohol and glycerol respectively.

| Vol.% alcohol in aq. solvent | Gms. gelatin dissolved per 100cc | Vol.% glycerol in aq. solvent | Gms. gelatin dissolved per 100cc |
|---|---|---|---|
| 5 | 0.029 | 0.0 | 0.030 |
| 10 | 0.031 | 10 | 0.025 |
| 20 | 0.032 | 20 | 0.015 |
| 30 | 0.035 | 33 | 0.007 |
| 50 | 0.002 | | |

## GELATIN

### Solubility of Gelatin in Water.
(Poutilov, 1935.)

Sheets of gelatin were weighed and immersed in water at constant temperature. After attainment of equilibrium, measured portions of the aqueous solution were removed and evaporated to dryness in weighed dishes and the residues dried at 90°-100° and then in a desiccator and weighed. The gelatin sheets which were removed from the water were dehydrated with the aid of alcohol and of ether and weighed. They were then immersed in a fresh portion of water and the above procedure repeated. This was done for a third time.

The successive amounts of gelatin dissolved are as follows:

| Weight of gelatin sheet | Gms. gelatin dissolved at 15° per 100cc solution | | | Gms. gelatin subsequently dissolved at 22° per 100cc solution |
|---|---|---|---|---|
| | 1st | 2nd | 3rd | |
| 0.5628 | 0.0752 | 0.0060 | 0.0013 | 0.1290 |
| 0.4382 | 0.0490 | 0.0047 | 0.0012 | 0.0942 |
| 0.4005 | 0.0421 | 0.0035 | — | 0.0821 |
| 0.2910 | 0.0399 | 0.0031 | 0.0005 | 0.0582 |

The gelatin after the third extraction with water at 15° was used for a similar experiment at 22° with results shown in the table. It was also found that although the residues obtained by evaporation of the solutions saturated at 15° redissolved completely in water, those from the solutions saturated at 22° did not redissolve. It was concluded that the gelatin which dissolves at 15° differs from that which dissolves at 22° and thus that micels of different chain length (mol. wt.) are present. The solubilities and the stability of the sols of gelatin depend upon the content of the fraction of lower molecular weight and increases in proportion to the amount of this fraction present in the gelatin. The author does not refer to the previous work of Mardles, 1930.

Attempts to determine the distribution coefficient of gelatin between water and cresylic acid (a mixture of cresols) are described by Woodman and Gallagher, 1929. The system is complicated by the fact that it yields emulsions. It is concluded that gelatin is in a colloidal condition in both solvents.

The curious circumstance was observed by Larson and Greenberg, 1933, that gelatin is soluble in 99.5% Acetic Acid only above certain concentrations and precipitates when the solution is diluted by the addition of more acetic acid. The minimum amount of gelatin which gave a clear solution with acetic acid at 20° was 3.1 gms. per 100 gms. of solution and 2.7 gms. at 25°. Above 80° there is no minimum amount which fails to dissolve. It was found that this curious behavior was not due to the presence of even as much as 5% of $H_2O$ in the acetic acid.

## KERATIN.

100 gms. $H_2O$ dissolve 8.71 gms. keratin at 20–25°. (Dehn, 1917.)
100 gms. aq. 50% pyridine dissolve 16 gms. keratin at 20–25°. "
Pyridine mixes with keratin in all proportions at 20–25°. "

## GLYCOGEN $(C_6H_{10}O_5)_x$

The solubility of glycogen at various alcohol and NaCl concentrations at 0° and at 22° was studied by Somogyi, 1934, for the purpose of finding the lowest alcohol concentrations applicable in the preparation and purification of glycogen

## ALLOPHANATES of STEROLS.

Results for the solubility of allophanates of cholesteryl, dihydro cholesteryl, sito steryl, and of caprosteryl in ethyl ether, Petroleum ether, chloroform, dichlor ethane, benzene, toluene, ethyl alcohol, acetone and pyridine are given by Tange and McCollum, 1928.

## FIBRINOGEN

Conditions of acidity and of temperature have been determined by Florkin, 1930 under which fibrinogen may be sufficiently purified of other proteins and its own denaturation products to yield a chemical individual of constant and reproducible solubility. Quantitative results are given for the solubility at 25° of purified fibrinogen in aqueous solutions of NaCl, $K_2HPO_4$, $KH_2PO_6$ + $K_2HPO_4$ .and $(NH_4)_2SO_4$.

## GLOBULIN (Serum).

### Solubility in Aqueous Magnesium Sulfate Solutions.

(Galeotti, 1906; Scaffidi, 1907.)

The precipitated globulin (from oxblood) was not dried, but pressed between filter paper, and an excess introduced into each $MgSO_4$ solution. After constant agitation for 12 hours, the saturated solution was filtered, weighed and evaporated to constant weight, the coagulated globulin then washed to disappearance of $SO_4$ and dried and weighed.

| Results for 10°. Gms. per 100 Gms. Sat. Sol. | | Results for 25°. Gms. per 100 Gms. Sat. Sol. | | Results for 40°. Gms. per 100 Gms. Sat. Sol. | | Results for 55°. Gms. per 100 Gms. Sat. Sol. | | Results for 70°. Gms. per 100 Gms. Sat. Sol. | |
|---|---|---|---|---|---|---|---|---|---|
| $MgSO_4$. | Globulin. | $MgSO_4$. | Globulin. | $MgSO_4$. | Globulin. | $MgSO_4$. | Globulin. | $MgSO_4$. | Globulin. |
| 0.06 | 0.07 | 0.06 | 0.07 | 0.06 | 0.42 | 0.40 | 1.14 | 0.71 | 0.34 |
| 0.18 | 0.34 | 0.21 | 0.61 | 0.31 | 1.42 | 0.88 | 2.14 | 2.52 | 0.55 |
| 0.65 | 1.63 | 0.63 | 2.20 | 0.61 | 5.39 | 1.60 | 3.34 | 4.74 | 1.14 |
| 2.11 | 3.35 | 2.28 | 5.56 | 1.92 | 8.31 | 5.64 | 5.06 | 6.83 | 1.17 |
| 4.32 | 4.42 | 3.35 | 6.07 | 5.40 | 8.63 | 10.81 | 3.10 | 9.22 | 1.76 |
| 13.63 | 2.60 | 16 | 4.03 | 14.72 | 3 | 13.84 | 2.11 | 13.29 | 1 |
| 20.86 | 0.37 | 21.30 | 0.95 | 18.47 | 1.02 | 17.90 | 0.69 | 15.38 | 0.37 |
| 24.18 | 0.18 | 25.47 | 0.03 | 27.03 | 0.01 | | | 17.67 | 0.07 |

The coagulation curve and freezing-point curve are also given.

Using serum albumin and serum pseudo globulin of beef blood, experiments on the variation of solubility with quantity of protein, the limiting solubility, the character of the heterogeneity of proteins and related problems are described by Bonot, 1934.

**ALBUMIN** (Egg).

100 gms. $H_2O$ dissolve 100 gms. egg albumin at 20–25°. (Dehn, 1917.)
100 gms. pyridine dissolve 0.1 gm. egg albumin at 20°–25°. "
100 gms. aq. 50% pyridine dissolve 6.29 gms. egg albumin at 20°–25°. (Dehn, 1917.)

Results for the solubility of egg albumin in aqueous solutions of ammonium sulfate at various temperatures are given by Sorensen and Hoyrup, 1915-17.

**ALBUMIN** (Egg)

SOLUBILITY OF EGG ALBUMIN IN AQUEOUS 25 PERCENT ETHYL ALCOHOL AT -5°.
(Ferry, Cohn and Newman, 1936.)

The egg albumin was recrystallized from ammonium sulfate solutions as described by Sorensen, 1917, and subsequently dialyzed in a cellophane membrane to remove $(NH_4)_2SO_4$. Electro dialysis was also used. It was concentrated in negative pressure dialyzers and dried at about 2° in a vacuum over $P_2O_5$. The solid albumin and the aqueous solvents were rotated from 5 to 7 days. The saturated solutions were filtered through sintered Jena glass filters in an atmosphere of Nitrogen under 15 pounds pressure. The content of protein in a weighed sample was determined by evaporation and weighing the residue in case no salt was present and by coagulating at 100° with 0.5 gm. $K_2SO_4$, filtering, washing and weighing when salt was present. Four egg albumen preparations were used and the following average results obtained.

| Gm. Mols. NaCl per liter Aq. 25 Vol. % $C_2H_5OH$ | Gms. Egg Albumen dissolved per 1000 gms. solvent | Gm. Mols. NaCl per liter Aq. 25 Vol.% $C_2H_5OH$ | Gms. Egg Albumen dissolved per 1000 gms. solvent |
|---|---|---|---|
| 0.0 | 0.13 | 0.101 | 1.2 |
| 0.00505 | 0.16 | 0.201 | 4.1 |
| 0.0101 | 0.20 | 0.349 | 18.4 |
| 0.0202 | 0.26 | 0.489 | 41.4 |
| 0.0505 | 0.52 | | |

**PLASMA PROTEINS**

The evolution of our knowledge concerning the separation and identification of plasma proteins and determinations of their solubility in concentrated phosphate solutions are given by Butler and Montgomery, 1932. Determinations of the effect of pH, of temperature and of the removal of lipids on this solubility are given by Butler, Blatt and Southgate, 1935.

**MYOGLOBIN**

Determinations of the solubility of carboxy myoglobin, prepared from horse heart, in concentrated aqueous solutions of $(NH_4)_2SO_4$ at 25° and pH 6.6 are given by Morgan, 1935. The results may be expressed by the equation log S (Solubility) = 8.0-0.92 $(T/2)$ (the ionic strength per

## HEMOGLOBIN.

100 gms. $H_2O$ dissolve 15.16 gms. hemoglobin at 20–25°. (Dehn, 1917.)
100 gms. pyridine dissolve 0.15 gm. hemoglobin at 20–25°. "
100 gms. aq. 50% pyridine dissolve 0.77 gms. hemoglobin at 20–25°. "

100 gms. absolute alcohol dissolve 0.37 gm. hemoglobin at 20-25°. } (Pucher and)
" quinoline " 0.23 " " " " } Dehn, 1921.)
100 gms. equimol. mixture of alcohol and quinoline dissolve 0.59 gm. hemoglobin at 20-25°.

## OXY HEMOGLOBIN

### Solubility of Oxyhemoglobin in Aqueous Potassium Phosphate Solutions at 0°.

(Cohn and Prentiss, 1927.)

Results for solutions of:

| pH 6.4 | | | pH 6.6 | | | pH 6.8 | | |
|---|---|---|---|---|---|---|---|---|
| Mols. conc. per liter $KH_2PO_4$ + $K_2HPO_4$ | Mol. % $K_2HPO_4$ | Gms. Oxyhemoglobin per 100 cc | Mol. conc. per liter $KH_2PO_4$ + $K_2HPO_4$ | Mol. % $K_2HPO_4$ | Gms. Oxyhemoglobin per 100 cc | Mol. conc. per liter $KH_2PO_4$ + $KHPO_4$ | Mol. % $K_2HPO_4$ | Gms. Oxyhemoglobin per 100 cc |
| 0.027 | 22.2 | 2.51 | 0.024 | 32.5 | 2.62 | 0.0213 | 42.8 | 3.32 |
| 0.079 | 26.6 | 3.54 | 0.070 | 37.1 | 3.12 | 0.062 | 50.0 | 3.81 |
| 0.153 | 32.0 | 4.38 | 0.136 | 41.9 | 4.07 | 0.121 | 53.7 | 4.85 |
| 0.366 | 37.2 | 6.29 | 0.326 | 48.2 | 5.87 | 0.293 | 59.4 | 6.66 |
| | | | 0.495 | 50.9 | 7.39 | | | |

The solubility of oxyhemoglobin is independent of the amount of protein in the solid phase. It dissolves in successive portions of the solvent to the same extent until the saturating body has been completely dissolved.

## CARBOXYHEMOGLOBIN

### Solubility of Carboxyhemoglobin in Aqueous Ethyl Alcohol Solutions Containing Sodium Chloride at -5°.

(Ferry, Cohn and Newman, 1938.)

The carboxyhemoglobin was prepared at 2° from horse erythrocytes and in order to be certain that it was always in the carboxy form it was saturated with CO whenever brought into solution. The carboxy hemoglobin was recrystallized from 25% ethyl alcohol. The saturated solutions were prepared in centrifuge tubes and 3 to 6 days rotation allowed for attainment of equilibrium. The dissolved carboxy hemoglobin was estimated by Kjeldal nitrogen determinations using the factor 16.86%

Results for aqueous Ethyl Alcohol of:

| 25 Volume percent | | 35 Volume percent | |
|---|---|---|---|
| Gm. Mols. NaCl per liter | Gms. hemoglobin per 1000 gms. solution | Gm. Mols. NaCl per liter | Gms. hemoglobin per 1000 gms. solution |
| 0.0101 | 0.055 | 0.0101 | 0.063 |
| 0.0202 | 0.096 | 0.0152 | 0.081 |
| 0.0505 | 0.21 | 0.0203 | 0.10 |
| 0.101 | 0.46 | 0.0507 | 0.40 |
| 0.202 | 1.40 | 0.1010 | 1.10 |

## CARBOXY HEMOGLOBIN

SOLUBILITY OF CARBOXY HEMOGLOBIN IN POTASSIUM PHOSPHATE SOLUTIONS OF pH 6.6 at 25°.
(Green, 1931.)

| Mol. conc. per liter | | Density | Gms. carboxy-hemoglobin per liter |
|---|---|---|---|
| $KH_2PO_4 + K_2HPO_4$ | Mol. % $K_2HPO_4$ | | |
| 1.072 | 52.6 | 1.1239 | 6.59 |
| 1.267 | 52.7 | 1.1453 | 2.59 |
| 1.267 | 52.7 | 1.1434 | 2.56 |
| 1.367 | 52.7 | 1.1574 | 1.64 |
| 1.462 | 52.1 | 1.1658 | 1.04 |
| 1.462 | 52.1 | 1.1646 | 1.05 |
| 1.657 | 52.7 | 1.1830 | 0.388 |
| 1.657 | 52.7 | 1.1843 | 0.438 |

Results at 0° similar to the above are given for carboxy-hemoglobin and for oxyhemoglobin. Results are also given for the solubility of carboxyhemoglobin at 25° in aqueous solutions of $Na_2SO_4$, $(NH_4)_2SO_4$, $MgSO_4$ and Na citrate.

The author also reviews the literature of the salting out of proteins from aqueous solutions and discusses the expotential equations which have been proposed and tested for their applicability to this phenomenon. Horse hemoglobin was used in the present experiments since it is a chemical individual and is readily separated by crystallization and, being a globulin, can be studied both in dilute and concentrated solutions. Its mol. wt. is approximately 66,800. In later papers by Green, 1931, 1932, results are given for the solubility of horse carboxy hemoglobin in concentrated and in dilute potassium phosphate buffer solutions of varying pH at 25° and of the solubility of carboxy hemoglobin at pH 6.6 in aqueous solutions of NaCl, KCl $Na_2SO_4$, $K_2SO_4$, $MgSO_4$ and $(NH_4)_2SO_4$ at 25°.

In a very careful study of the solubility and dissociation tendency of carboxy hemoglobin of the horse in ammonium sulfate solutions, Sorensen and Sorensen, 1933, give results showing that the solubility of carboxy hemoglobin in ammonium sulfate solutions is expressed by the equation $\log s = \alpha.S+\beta$ proposed by Cohn. They also show that with changes in hydrogen ion activity the solubility curve shows two minima of which one is at about pH 6.6 (the isoelectric point of hemoglobin) and the other is at about pH 5.4, corresponding probably to a moderately difficult soluble hemoglobin sulfate of which the sulfuric acid content is about 12-13 mol. per mol. of hemoglobin hydrate.

Determinations by Green, Cohn and Blanchard, 1935, of the solubility of Human hemoglobin in concentrated salt solutions show that it remains dissolved in a phosphate solution in which horse hemoglobin is essentially insoluble. Human hemoglobin behaves much more like an albumin than does horse hemoglobin. The maximum solubility of the latter is 0.052 gm. per liter in 0.33 molar phosphate buffer at pH 6.6 at 25°. Human hemoglobin is as soluble as this in 1.96 molar phosphate buffer, but at this ionic strength the hemoglobin of the horse is only one-thousandth as soluble as that of man.

## CHOLESTEROL-DIGITONIDE.

Solubility in Water and in Ethyl Ether. (Mueller, 1917.)

The compound was prepared by precipitating reerystallized eholesterol, made from gall stones, by digitonin, filtering, washing-throughly with aleohol and ether and drying. Some of the resulting compound was shaken with ether for 24 hours at room temperature. After filtering, exaetly 100 ee. were evaporated in several portions from a small weighed poreelain dish, the residue was dried at 110° and weighed. The average of 3 determinations gave :

0.0007 gm. Cholesterol-Digitouide per 100 cc. of ether.

Similar determinations, using boiling water as the solvent, gave :

0.0006 gm. Cholesterol-Digitonide per 100 cc. of $H_2O$.

## PEPTONE.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 100 gms. | $H_2O$ | dissolve | 42.2 | gms. | peptone | at 20–25°. | (Dehn, 1917.) |
| " | pyridine | " | 0.22 | " | " | " | " |
| " | aq. 50% pyridine | " | 12.6 | " | " | " | " |

## UREASE

Determinations of the minimum solubility of crystalline urease in dilute buffer solutions were used by Sumner and Hand, 1929, as a means of finding its iso electric point.

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[1]The following abbreviations are used in the name index.

alc.—alcohol
aq.—aqueous
Cmpd(s)—compound(s)
C.s.t.—critical solution temperature
Dist.—distribution
f.pt.(s)—freezing-point(s)
EtOH—ethyl alcohol
org.—organic
ref.—reference
sol(s)—solution(s)

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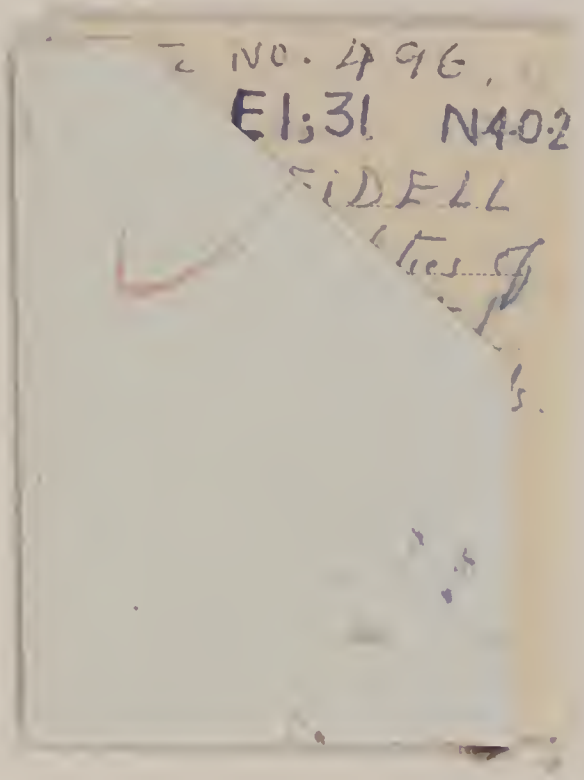
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